New Scientist

WEEKLY 16 March 2024

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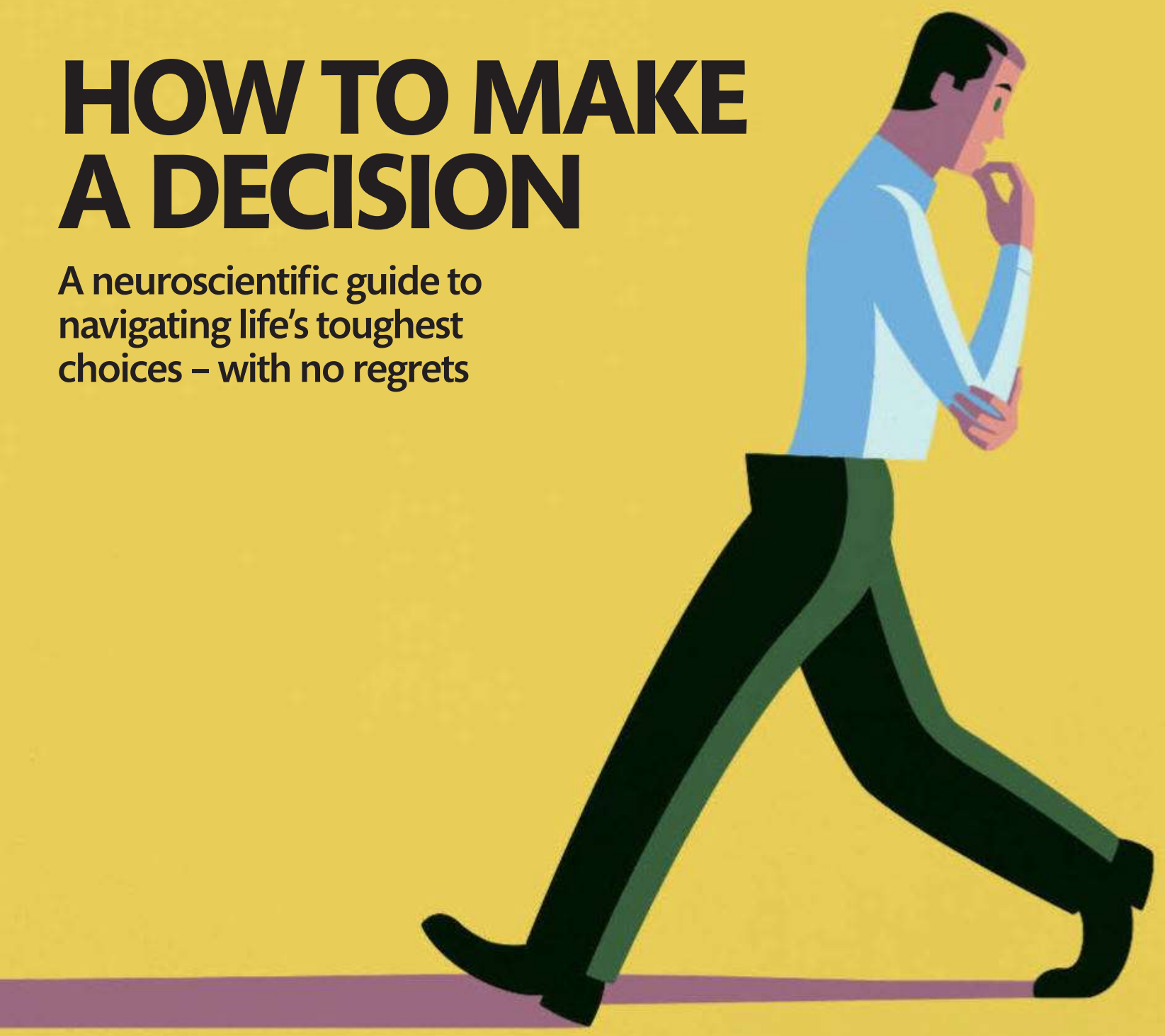

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YES

QUIRKY MEET QUIRKY

NO

Read a book on fungi?

YES

QUIRKY MEET QUIRKY

NO

Ever wished you were a seahorse?

YES

QUIRKY MEET QUIRKY

NO

Think Krypton is the best element?

YES

QUIRKY MEET QUIRKY

NO

Convinced black holes are portals to

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This week's issue

On the cover

32 How to make a decision
A neuroscientific guide to navigating life's toughest choices – with no regrets

8 Gaza's humanitarian disaster
How the war will create a decades-long health crisis

Vol 261 No 3482
Cover image: Jon Krause

12 Why we will never resurrect the woolly mammoth

15 Weight-loss pill may work better than Wegovy

36 Extreme megaprojects that could save the planet

13 Why 10,000 steps a day really works **24** Protecting the world's largest flowers **46** The best way to slice bread

41 Features
"Ketamine clinics can be more akin to a spa than a hospital ward"

News

10 Australia in orbit
Private firm hopes to launch rocket in the coming weeks

14 Quantum claim
D-Wave says it has achieved "computational supremacy"

16 Elephant graveyard
The animals have been seen burying their dead in India

Views

21 Comment
Fighting deepfakes is an evolutionary arms race, says Jonathan R. Goodman

22 The columnist
Does biodiversity offsetting work, asks Graham Lawton

24 Aperture
Saving *Rafflesia*, the world's largest flowers

26 Letters
Why aren't we all cannibals?

28 Culture
How memory shapes our world and is key to creativity

DANNY GREEN/NATUREPL

29 Top dogs A new book asks if we should reintroduce wolves to Britain

Features

32 To leap or not?
Sound ways to decide whether you should gamble when it comes to life's big choices

36 Audacious engineering
The megaprojects that may help get carbon emissions to zero

41 Ketamine therapy
How the psychedelic rave drug became a treatment for PTSD, depression and addiction

The back pages

44 Stargazing at home
How to spot the Spring Triangle

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
Do climbing plants twine in only one direction?

48 Feedback
Edible robots, sliceable ketchup and financial smirks

48 Twisteddoodles for *New Scientist*
Picturing the lighter side of life

Elsewhere on New Scientist

Instant Expert

Particle physics: Revealing the mysteries of matter

In 2012, the Large Hadron Collider found the Higgs boson, the final piece in the standard model of particle physics. So, is the standard model complete? Might there be new particles and forces at much higher energies? And what cracks in the current theory can offer a way through? Join six experts at London's Conway Hall on 13 April to find out everything we know about what stuff is made of.

newscientist.com/events

Tour

The science of the waterways: England and Wales

Join canal expert Roger Butler on a tour of six of Britain's seven wonders of the waterways. Learn about these engineering marvels and the history of the island's 200-year-old network of canals. This seven-day tour starts on 6 July and costs £1898.

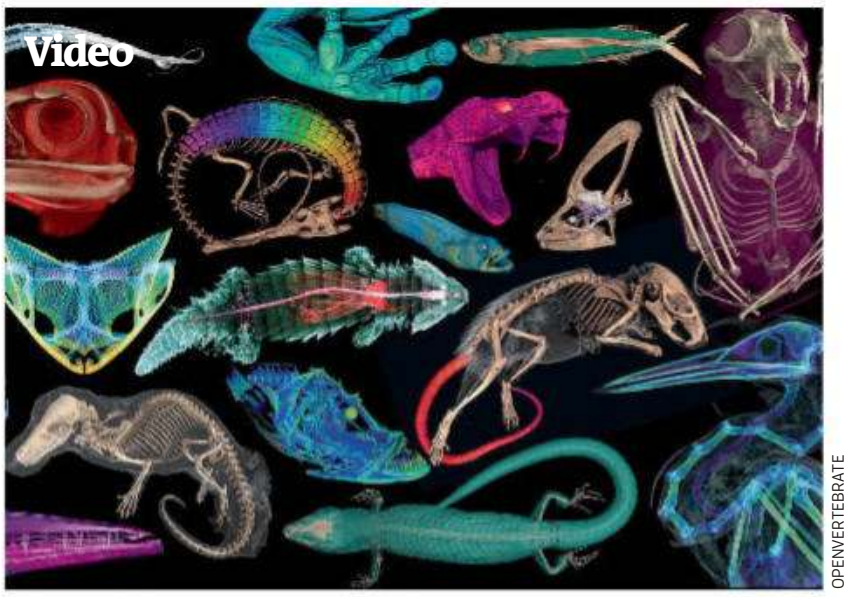
newscientist.com/tours

Podcast

Weekly

This week, the team consider why a geological committee has rejected a proposal to name our current era "the Anthropocene". They also unpack the news that we are one step closer to bringing extinct animals like the woolly mammoth back from the dead. Plus, researchers have been cross-breeding cheese moulds in the hope of making novel and resilient strains of blue cheese.

newscientist.com/nspod



OPENVERTEBRATE

Hidden depths Explore the interiors of these museum critters

SILVIA FERRARA

Rongorongo tablets What are the origins of writing on Rapa Nui?

Video

Under the skin

The openVertebrate project uses X-ray CT scans to unveil specimens held in museum collections from the inside out. Explore all kinds of amphibians, reptiles, fish and mammals in this digital library that reveals skeletons, muscles, circulatory and nervous systems, internal organs, eggs and stomach contents. You can even download mesh files to plug into a 3D printer.

youtube.com/newscientist

Newsletter

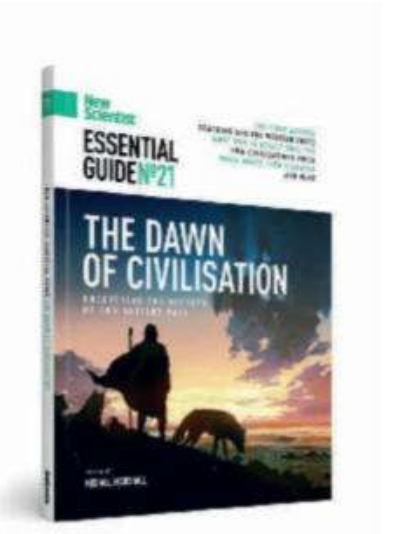
Our Human Story

When you think about the invention of writing, your mind might turn to the development of cuneiform script in Eurasia or hieroglyphics in ancient Egypt. Michael Marshall considers new evidence that the people of Rapa Nui (Easter Island) invented writing independently – long before Europeans arrived there.

newscientist.com/our-human-story

Podcast

"The company wants woolly mammoths to be grazing in the Arctic, turning forests into grasslands"



Essential guide

Where are the origins of humanity? When did civilisation begin and what does the future of society hold? Uncover the secrets of the past in this *New Scientist Essential Guide* covering all that we know about ancient civilisations. Now available to read in the app or buy in print from our online shop.

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Time for change

Quibbling over definitions of the Anthropocene will only hold us back

QUICK – how many planets are there in the solar system? If you were born in the 20th century, the answer on the tip of your tongue might be nine. Of course, the official answer is eight, ever since an International Astronomical Union vote in 2006 that ejected Pluto from the line-up.

One issue was that if Pluto had been allowed to remain a planet, it would have meant admitting many other Pluto-like bodies to the planetary roster. The group ultimately opted to keep the solar system neat and tidy, dumping Pluto and its ilk in a box marked "dwarf planet". The decision remains controversial among both scientists and the general public.

Nearly two decades on, history seems to be repeating itself. A vote by the Subcommission on Quaternary Stratigraphy, the guardians of the strata that define geological time, has rejected a proposal to declare a new epoch called the Anthropocene, in which humanity has left a distinct mark on the planet, ending the 11,700-year Holocene (see page 17).

"Climate change is the defining issue of our age, so the term 'Anthropocene' is a useful tool"

The term Anthropocene was popularised in the 2000s, and the idea of an official epoch has been in the works for 15 years. In that time, "Anthropocene" has entered the public lexicon as a way of making sense of a world ravaged by human activity, whether through climate change, plastic pollution or a whole host of other environmental issues. It seems a shame to let it go now.

Part of the argument for rejecting the Anthropocene is a disagreement about when exactly it began. Scientists need firm definitions, but given that existing epochs last anywhere from hundreds of thousands to tens of millions of years, quibbling about whether humanity's influence should be marked by the industrial revolution (around 1760) or the detonation of the first nuclear weapon (1945) feels like a rounding error.

Given climate change is the defining issue of our age, and the Anthropocene is a useful tool for talking about it, perhaps a little fudging is in order – even if it leaves a few geologists stony-faced in response. ▮

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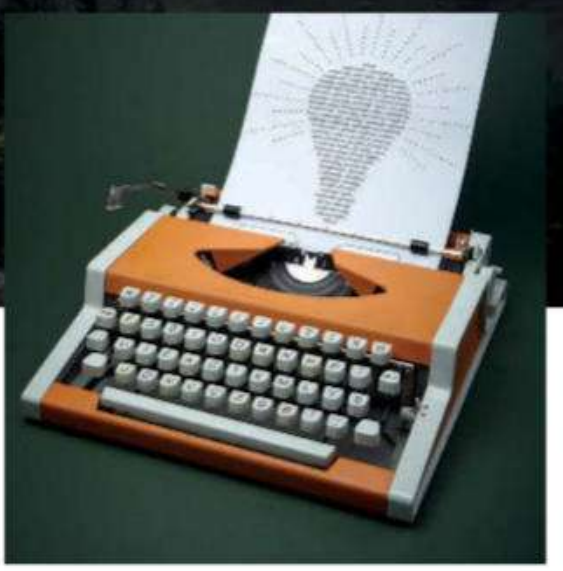
The science of botanical gardening and horticulture: Surrey

13 - 15 September 2024 | 3 days

Explore the science of botany and horticulture on this deep-dive weekend break unravelling the secrets of our gardens and natural landscapes. With insights from leading biologists, horticulturalists and academics plus a behind-the-scenes visit to Royal Horticultural Society's headquarters Wisely. Immerse yourself in a broad spectrum of botanical subjects from the subtleties of soil science, identifying the plant pathogens and diseases that are impacting biodiversity and discovering how plant genetics are adapting to our rapidly changing environment.



The art and science of writing science fiction

November 2024

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Find out more

newscientist.com/weekenders

News

Language bias
AI chatbots "think" in English even if asked in Chinese **p13**

Cheese dreams
Hybrid moulds could herald new types of Stilton **p14**

Maternal care
Amphibian feeds hatchlings "milk" from its rear end **p15**

Cosmic rollercoaster
Bizarre galaxy died very young but may come back to life **p18**

Pore blocker
Make-up may damage skin health during exercise **p19**

BERNT OLSEN

Astronomy

A blazing green comet is coming

This beacon of light haring through the night sky is comet 12P/Pons-Brooks, glimpsed from outside Tromsø, Norway. It is one of the brightest comets known and orbits the sun every 71 years. Recorded sightings of 12P/Pons-Brooks by Chinese and European astronomers date back to at least 1385. The comet may be visible to the naked eye in the coming weeks from both hemispheres of the planet.

Health

Gaza's inescapable health crisis

Physical injuries, malnutrition and mental health issues are widespread for Palestinians and are creating problems that will last for decades, finds **Grace Wade**

ISMAEL MOHAMAD/UPI/SHUTTERSTOCK

Palestinians getting food from a charity kitchen in Rafah, Gaza, on 6 March

THE situation for Palestinians in Gaza is rapidly evolving into the worst humanitarian crisis in modern memory. More than three-quarters of its 2.2 million residents, half of whom are children, are internally displaced, trapped in one of the most densely populated areas in the world with minimal access to food, water or healthcare.

Since 7 October, when Hamas militants from Gaza invaded Israel, killed more than 1000 civilians and took hundreds of hostages, Israel has intensely bombed the enclave, hindered the flow of humanitarian aid and destroyed civilian infrastructure. As a result, more than 30,000 Palestinians have died in Gaza – mostly women and children – according to the UN, and more than 72,000 have been injured.

Yet these figures mark only the beginning of the public health catastrophe. Those who survive the war will face lifelong effects. Thousands of Palestinians will be living with missing limbs, compromised immunity, mental illnesses and other conditions. Meeting their needs will be a decades-long undertaking, one that no global aid organisation has adequately planned for.

The World Health Organization (WHO), the World Food Programme, UNICEF, the Palestine Red Crescent Society, CARE International and Doctors Without Borders all lack concrete, long-term plans to address health needs in Gaza, according to information each organisation shared with *New Scientist*. Save the Children and the International Committee of the Red Cross didn't respond to questions on their long-term plans.

The lack of planning for the coming decades is partly due to the enormity of the humanitarian crisis. Most people in Gaza are living in crowded conditions without sewage treatment and garbage removal. On average, people have less than 1 litre of clean water per day. As a result, infectious disease is rampant.

A survey in a limited number of refugee shelters in December and January found that at least 90 per cent of children under 5 years old had one or more infectious illnesses and 70 per cent had experienced diarrhoea in the past two weeks. "And that doesn't account for the hundreds of thousands of people who aren't in refugee shelters," says Margaret Harris at the WHO.

Hunger is also rampant. Almost two-thirds of households eat only one meal a day and much of the population faces malnutrition and starvation (see graphs, above right). Gaza's Hamas-run health ministry reported on 7 March that 20 people, including 15 children, had recently died from malnutrition and dehydration. Poor surveillance means the real numbers are probably far higher.

"The difficult thing about malnutrition in children is that it begets more illness," says Tanya Haj-Hassan at Doctors Without Borders. Malnourishment makes infection more likely, which damages the intestine, making it hard to absorb nutrients. "So they become more malnourished, more immunocompromised and it just becomes this vicious cycle that's essentially a snowball down to death," she says.

The bombing creates a constant injury risk. UNICEF found that, by December, more than 1000 children had lost one or both of their legs since the conflict began, or more than 10 children a day, on average. And there are few options to obtain care for these injuries: as of 21 February, only 18 of Gaza's 40 hospitals were still functioning, but with reduced capacity. "They don't have drugs. They don't have machines. They don't have power. They might have a few doctors who are running an emergency room. So there's really no functioning health system," says Selena Victor at humanitarian organisation Mercy Corps, which is providing emergency food in Gaza.

"We've not seen such a level of violence, horror, fear and deprivation enacted on any population in modern

Broken hospital system

Gaza has **40** hospitals

14
are partially functioning (35%)

4
are minimally functioning (10%)

22
aren't functioning (55%)

Source: Global Nutrition Cluster Nutrition Vulnerability and Situation Analysis – Gaza

history," says Harris.

Even if the war ends tomorrow, lots of survivors will face lifelong health consequences. Many will have physical disabilities. Others will have severe mental illness. Some may develop lung conditions, cancer and heart disease from the chemical pollutants in bombs and destroyed buildings, says Harris.

The impact will be most severe for children. Persistent malnutrition early in life stunts growth and impairs brain development, causing deficits in cognition, memory, motor function and intelligence, says Haj-Hassan. It also weakens the immune system, leaving children vulnerable to illness. Research shows that malnutrition during pregnancy increases the risk of babies developing obesity, hypertension, heart disease and type 2 diabetes later in life. A February report from Project Hope, an international aid organisation, found that 1 in 5 pregnant women treated at a Gaza clinic were malnourished, as were 1 in 10 children seen there.

But the most widespread harm will be the mental health effects, says Harris. "Just imagine what it's like for the people who are going through this every day, relentlessly. They have a terrible sense of uncertainty – no idea where to go, what's going to happen next, where the next little bit of food is going to come from." Such traumatic experiences are associated with depression, anxiety, post-traumatic stress disorder and suicidal thoughts. In children, these experiences can disrupt brain development and raise the risk of learning disabilities and mental health conditions. "We're going to see an enormous burden of mental illness," says Harris.

Adults who experienced childhood adversity also have 12 times the risk of developing alcohol and drug use disorders and attempting suicide. They are more likely to have physical health conditions, too, such as heart disease or cancer. Young men who survive conflict have almost triple the rates of severe mental health conditions, such as psychosis, of those who don't experience war.

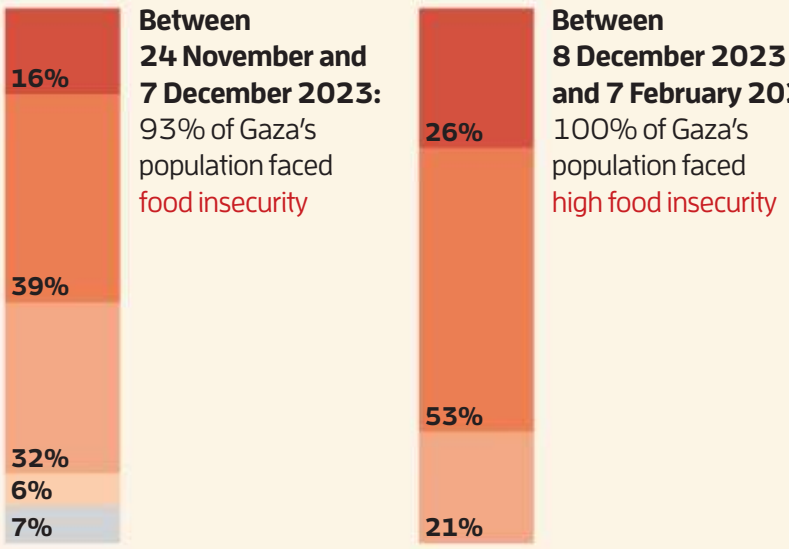
To deal with such consequences, long-term health plans are required for Gaza, says Victor. These will have to address the need to rebuild infrastructure, develop mental and physical rehabilitation programmes and routinely screen for illness.

"It seems absurd to be talking about what the municipal authorities will look like when, right now, people are dying trying to get a handful of bread for their families," says Victor. "But we need to think about it."

Yet most organisations have only just begun to do so. The few protocols in place – including those by the Palestine Red Crescent Society and CARE International – merely cover the next year or two. The WHO is developing plans to address health needs from next month to the end of the year. "We're working with several different scenarios. The good scenario is a ceasefire that helps us to then genuinely look at [long-term plans]," says Harris. It is also plausible that the war continues.

This uncertainty, along with the question of who will govern Gaza in the aftermath of the conflict, makes preparations hard. "Why we are desperate to see not just a ceasefire, but a peaceful resolution," says Harris, "is that until we've got that, any plan, anything we even consider, is just castles in the air." ▮

The food situation is worsening


16%
39%
32%
6%
7%
Between 24 November and 7 December 2023: 93% of Gaza's population faced food insecurity
26%
53%
21%
Between 8 December 2023 and 7 February 2024: 100% of Gaza's population faced high food insecurity
Catastrophic levels of food insecurity, with starvation and death evident
Emergency levels of food insecurity, with high levels of malnutrition
Crisis levels of food insecurity, with above usual acute malnutrition
Stressed food security, with minimally adequate levels of food
Able to meet essential food needs

Source: IPC Global Initiative – Special Brief – Gaza Strip

30,000
Palestinian people have died in Gaza as a result of the conflict

72,000
of them have been injured

90%
of children under 5 in Gaza have one or more infectious illnesses

Two-thirds
of Gaza's households eat only one meal a day

One-quarter
of the population of Gaza is facing imminent starvation

Source: United Nations Office for the Coordination of Humanitarian Affairs; Global Nutrition Cluster Nutrition Vulnerability and Situation Analysis – Gaza

A billion-dollar catastrophe

It will take a huge amount of money to address the devastation in Gaza. Margaret Harris at the World Health Organization says early estimates suggest $204.2 million will be needed to fund its health emergency plan in Gaza for 2024 alone.

A spokesperson for the Palestine Red Crescent Society says the organisation has a $300 million budget for its campaign in Gaza until the end of 2025. Roughly $38 million of that will be used for the health sector, including restocking medical supplies, deploying additional ambulances and preventing infectious disease.

This won't begin to address the long-term health needs of Palestinians in Gaza though. It is hard to estimate what will be needed, but Harris says, in the long run, "it is fair to say we'll be looking at billions".

Space

Australia prepares for trip to orbit

Private firm Gilmour Space is hoping to launch an Australian rocket in the coming weeks

James Woodford

THE Australian government is expected to approve the country's first private orbital rocket launch within weeks. This should let the country join just a handful of space-faring nations that have launched their own rockets into orbit.

Gilmour Space, which has developed the new rocket, announced this week that the Australian Space Agency (ASA) has granted it approval to operate the Bowen Orbital Spaceport in North Queensland, Australia. The company has also set a goal of having Australian astronauts in orbit, launched from Australia, by the end of this decade.

Its Eris Block 1 rocket is 25 metres tall, weighs 36 tonnes and is designed to carry a payload of more than 300 kilograms into an orbit 500 kilometres above Earth. The ASA is now working to provide a permit for the vehicle's first launch.

David Doyle at Gilmour Space says he expects that the first test launch will attempt to deploy a satellite as soon as April or early May. The company then aims to have its first commercial payload in space by early 2025 and hopes to have up to 10 launches annually within two to three years.

"We really want to put Australian astronauts in space from Australian rockets, and we are looking to do that by the end of the decade," says Doyle.

Launching the Eris Block 1 three-stage rocket from the new spaceport is an extremely "ambitious and bold" decision, says Paulo de Souza at Griffith University in Queensland, because most companies would first attempt a single-stage rocket launch.

"But in space, you either be bold or you go home," says de Souza. "It's incredible that they have put all this infrastructure together in such a short time."

Australia does have a number of private spaceports elsewhere in the country, including in Arnhem Land in the Northern Territory and in South Australia, but the new facility at Bowen is the first to have approval to operate for private orbital launches, rather than suborbital ones.

Only one orbital flight from Australia has ever been attempted, when the UK used the Woomera Rocket Range in South Australia to launch its Black Arrow rocket into low Earth orbit in 1971 – the last ever flight of the vehicle.

The Eris Block 1 rocket is designed to carry a 300-kilogram load

GILMOUR SPACE TECHNOLOGIES

Equatorial boost

De Souza says Bowen has many advantages as a spaceport. It is close to the equator, giving rockets a boost from Earth's rotation. It is also next to the Pacific Ocean, which means almost no infrastructure or population centres that could be affected by a failed launch exist nearby, and this allows for launches into a wide array of orbital angles.

The location also isn't prone to constant storms and bad weather. "Most of the year, the skies are clear at Bowen," says de Souza. "If this company is successful, then the access to space will become a reality for Australians." ▮

Climate change

The world just had the hottest February ever recorded

WE JUST experienced the hottest February on record, with the global average temperature rising 1.77°C above the pre-industrial average for the month, according to the European Union's Copernicus Climate Change Service (C3S). That makes it the ninth month in a row to set a monthly heat record.

"As remarkable as this might appear, it is not really surprising, as the continuous warming of the climate system inevitably leads to new temperature extremes," said Carlo Buontempo at C3S in a statement.

Europe saw particularly anomalous heat in February, with average temperatures rising 3.3°C above the monthly average for 1991 to 2020. High temperatures and dry weather also drove fires in North and South America.

The ocean heat was even more extreme, with the average global sea surface temperature in February edging out August 2023 for the hottest month at sea on record. The average sea surface temperature of 21.09°C registered on one day at the end of February was the hottest daily record, and sea ice in both the Arctic and Antarctic was below average.

Richard Allan at the University of Reading in the UK says the record heat is primarily caused by rising concentrations of greenhouse gases in the atmosphere, combined with the warming influence of the El Niño climate pattern in the Pacific Ocean.

1.77°C

Global average temperature increase above pre-industrial levels in February

A reduction in reflective aerosols thanks to lower air pollution levels also contributed to the heat in some places, he says.

El Niño, which emerged in June 2023 and helped make last year the hottest on record, is set to weaken and possibly give way to a cooler La Niña by the middle of this year, according to a projection by the US National Oceanic and Atmospheric Administration. But that might not bring immediate respite. Historically, the year after El Niño's emergence bears the brunt of its heating effects. ▮

James Dinneen

Botany

Plants make 'distress calls', but can other plants hear them?

Adrian Barnett

THE idea that plants communicate by sound has caught on widely – but there is no solid evidence it is true, according to a review of studies.

"Plants are not capable of exchanging information through the acoustic channel," says Nicolas Mathevon at Jean Monnet University in Saint-Étienne, France.

Since as far back as the 1970s, we have known plants can make sounds when stressed or under attack. Water moving through the plants' vascular tissue can result in squeaks and chirps if fluid is in short supply, while rhythmic chewing by caterpillars can make leaves vibrate. Several studies have proposed that such sounds might be perceived by other plants, which respond by developing chemical or physical defences, for example.

However, Mathevon and his colleagues say these sounds are very high-pitched and low energy, so are unlikely to propagate more than a few centimetres (*New Phytologist*, doi.org/mk4p). Plus, there is no known means by which plants could detect them.

SHUTTERSTOCK/AZURE

Plants can make sounds when being nibbled by caterpillars

"This article provides a welcome corrective to the idea that if a plant produces a sound, it must be using [this] to communicate," says Rex Cocroft at the University of Missouri.

Laura Arru at the University of Modena and Reggio Emilia, Italy, believes this conclusion is premature, though, until we work out how plant communication can be experimentally evaluated. ▮

Palaeogenetics

Genomes of Indian people include a wide range of Neanderthal DNA

James Woodford

FOTOFLIRT/ALAMY

People in India have gene sequences not seen anywhere else

THE largest ever genome study of South Asian people has found a wide range of Neanderthal DNA sequences in modern Indian people. The findings raise the possibility of building a full Neanderthal genome from living humans, instead of relying on DNA from ancient remains.

All modern humans except African people retain an average of about 1 to 2 per cent of their genetic ancestry from archaic hominins, including Neanderthals and Denisovans. African people also get about 0.5 per cent of their DNA from Neanderthals on average, even though Neanderthals never lived on the continent.

Studies of ancient DNA have produced three Neanderthal genomes that are about 70 per cent complete. But such ancient DNA has degraded before analysis, so it would be better to reconstruct the genome of ancient humans from sequences surviving in modern people, says Laurits Skov at the University of California, Berkeley.

He and his colleagues have analysed the genomes of nearly 2700 people born in 23 states in India. They included speakers of at least 26 different languages who belonged to diverse caste groups and were from both rural and urban areas.

The people in the study derived 1 to 2 per cent of their ancestry from archaic hominins, similar to other non-African populations. But the Neanderthal DNA included more than 90 per cent of known Neanderthal gene sequences, more than in any modern population that has been studied before. Nearly 12 per cent of these sequences haven't been found in any other region.

"India is likely to have been inhabited since at least 54,000 years ago"

The study also reveals that most of the overall genetic variation in Indian people stems from a single major migration out of Africa that occurred some 50,000 years ago.

Archaeological finds have shown that some modern humans migrated out of Africa before this point, but these migrations contributed little genetic ancestry to modern Indian people. Most of their ancestry is derived from three groups related to ancient Iranian farmers, Eurasian Steppe pastoralists and South Asian hunter-gatherers, the research found (bioRxiv, doi.org/gtj3xn).

From the DNA of study participants, the team was able to reconstruct nearly two-thirds of the Neanderthal genome and nearly a quarter of the Denisovan genome.

A previous study based on DNA from 27,566 people in Iceland was only able to reconstruct 41 per cent of the Neanderthal genome, says Skov. "So there are just more different puzzle pieces present in India, even though we looked at 10 times less individuals."

He says the amount of Neanderthal DNA recovered from other regions of the world has begun to plateau, while that from India still has considerable untapped potential.

"But if we will ever be able to reconstruct 100 per cent of the genome is another matter," says Skov. "Probably not, but we can for sure reconstruct more."

Hardip Patel at the Australian National University says this study adds more than 26 million genetic variations to the global catalogue, showing the importance of diversity in genomic studies. "They use these genomic data to show that India is likely to be inhabited since [at least] 54,000 years ago, which is remarkable." ▮

Briefing

Will woolly mammoths be resurrected soon?

Biotechnology company Colossal claims it has taken a "momentous step" towards bringing back ancient pachyderms. **Michael Le Page** delves into whether such a feat is possible

A FIRM set up to resurrect extinct animals says it has achieved a breakthrough in its goal of bringing back the woolly mammoth. On 6 March, Colossal announced that its team had turned normal elephant cells into stem cells, which could lead to a mammoth-like creature. "This is a momentous step," its CEO, Ben Lamm, said in a press release. Here is what you need to know.

QUANGTRUNGART/SHUTTERSTOCK

Unlike extinct woolly mammoths, most modern versions would have no tusks

Is it possible to bring the woolly mammoth back from extinction?
No it isn't and never will be. While the genomes of several frozen mammoths have been sequenced, these are full of gaps. However, it should be possible to edit the genomes of elephants to make them mammoth-like.

Colossal acknowledges on its website that what it plans to create will be "a cold-resistant elephant", but says the animal will have "all the core biological traits of the Woolly Mammoth".

Will these edited elephants look like mammoths?
According to Colossal, they will even sound like them, although how it knows what mammoths sounded like is unclear. When it comes to their appearance, there will be at least one major difference: the vast majority will have no tusks to avoid ivory poaching, says geneticist George Church, Colossal co-founder.

Why does Colossal need to make elephant stem cells?
The company has been editing the genomes of elephant cells to make them more mammoth-like. But to create a living, mammoth-like elephant, it needs to generate embryos containing an edited genome. In theory, one way to do this is to turn gene-edited elephant cells into so-called induced pluripotent stem (iPS) cells, and then to turn those into eggs and sperm cells.

What are iPS cells?
Pluripotent stem cells can turn into any cell in the body, including eggs and sperm. They occur naturally in embryos, but can be produced from adult cells by adding certain proteins, hence the "induced". They have been made in many animal species, but no one had managed to induce elephant cells to become pluripotent.

How did Colossal manage it?
Among other things, it genetically modified Asian elephant cells to produce the key proteins. Even then, it still took two months to transform the cells into iPS cells. "We do want to make the process more efficient and faster, but I think it's a great start," says Eriona Hysolli at Colossal. The DNA that codes for the key proteins can be easily removed, she says.

Next, Colossal plans to turn these iPS cells into eggs and sperm, but that could take years. "It's been done mainly in two species, which is mouse and human," says Church. "And neither one of them is perfect."

So it could be decades before we see mammoth-like elephants?
Colossal claims its first "mammoth" will be born by 2028. Hysolli says the researchers aim to make just 50 to 100 genetic edits to elephant cells, which is feasible. But to generate embryos in time to meet the deadline, they will almost certainly have to transfer the edited genomes into elephant eggs with the cloning technique used to create Dolly the sheep.

Because elephants have a two-year gestation period, these embryos would have to be created and implanted by about the end of 2026.

Will cloning the edited cells work?
It might, but, typically, just a few per cent of cloned embryos develop into healthy animals. "There are bound to be failed attempts. How many elephant cows will have to be subjected to the experimental pregnancies?" asks stem cell expert Dusko Ilic at King's College London.

"Just because we have the capability to do something new, that does not mean that we should pursue it without careful consideration of the ethical implications and consequences."

Where will these mammoth-like elephants live?
Mammoths were everywhere in the Arctic circle, so Siberia, Alaska and Canada are all possibilities, says Hysolli, and Colossal is already having "very fruitful collaborations" with government agencies, local governments and Indigenous peoples.

Why is Colossal aiming to bring back the mammoth?
The firm claims that rewilding the Arctic with mammoths can help limit climate change by reducing permafrost melt and locking away carbon in the form of frozen organic material. "The Arctic is the perfect place to be sequestering carbon because every year it freezes another layer of topsoil," says Church. "And then the herbivores poop on top of that."

Could these creatures really help limit further warming in the Arctic?
That remains to be established, but there is some plausibility. One small study suggests large herbivores can lower permafrost temperatures by flattening insulating snow in winter. And if the edited elephants limited forest expansion, that would also help, as dark trees in previously flat, snowy areas can have a warming effect by absorbing more sunshine. But many thousands would be needed to have a significant impact, and it could take a century to breed that many. ▮

Technology

AI chatbots 'think' in English even when asked questions in other languages

Chris Stokel-Walker

THE artificially intelligent large language models (LLMs) behind chatbots may "think" in English, even if tasked to do something in a different language. This is because their training data is biased, encoding concepts more common in English language cultures.

LLMs have become popular since the November 2022 release of ChatGPT, and many examples can answer questions put to them in a number of languages, responding in the same language.

To see which language the LLMs actually use to process queries, Chris Wendler and Veniamin Veselovsky at the Swiss Federal Institute of Technology in Lausanne and their colleagues looked at three versions of the Llama 2 model, made by Facebook-owner Meta.

"We opened up these models and looked at each of the layers," says Veselovsky. LLMs are made up of layers of processing. These translate written prompts into tokens – which are words or sections of words – then try to contextualise each token to provide an answer.

"Each of these layers does something to the input, the original prompt that you give it," says Veselovsky. "We wanted to see, can we see that the internal layers are actually processing in English?"

"Using English as the intermediary risks superimposing a limited world view onto others"

The Llama 2 models were chosen because they are open source, so available to the public, and therefore it is possible to look at each stage of the processing, unlike with other LLMs, such as those behind ChatGPT. The method used should extrapolate to any open-source model.

The researchers fed three types of prompt to each model in Chinese, French, German and Russian: one asking it to repeat the word it was given; another asking it to translate from one non-English language to another; and the third asking it to fill in a single-word gap in a sentence, such as "A ___ is used to play sports like soccer and basketball".

The researchers tracked back the processes the LLM went through to answer each prompt. They found that the path of processing through the layers almost always passes via what they call the English subspace. If asked to translate Chinese to Russian, the correct Russian characters travel through the English subspace, before going back to Russian, says Veselovsky, which is a strong indication that English is being used by the models to help them deal with concepts (arXiv, doi.org/mkks).

The results are unsurprising, but could be a cause for concern. "AI developers train their models mostly on English-language data," says Aliya Bhatia at the Center for Democracy & Technology in Washington DC. "But using English as the intermediary through which to teach a model how to analyse language risks superimposing a limited world view onto other linguistically and culturally distinct regions."

This is a big issue for artificial intelligence, says Carissa Véliz at the University of Oxford. "If English is the main language in which systems process queries, we will likely lose concepts and nuances that can only be appreciated in other languages," she says.

There are also risks relating to incorrect answers that the AI may "hallucinate", says Bhatia. "If a model is used to generate text in a language it has not been trained on, it may result in culturally irrelevant hallucinations, and if a model is used to make asylum decisions for a community that doesn't fit within the Anglocentric imagination of society, the model may stand between an individual and access to safety," she says. ▮

Health

Walking 10,000 steps a day really can make us healthier

TAKING between 9000 and 10,000 steps per day seems to reduce the risk of an early death or heart-related event, adding legitimacy to an idea that has been criticised as unscientific.

The origin of the belief that people should aim for 10,000 steps a day is unclear, but it has been linked to a marketing campaign promoting pedometers in Japan.

Now, a study by Matthew Ahmadi at the University of Sydney, Australia, and his colleagues suggests the figure could hold merit.

The team analysed more than 72,000 participants, with an average age of 61, as they wore a movement-tracking accelerometer on their wrists for one week. "We were able to quantify daily steps," says Ahmadi.

The study tracked the participants for an average of just under seven years, during which time 1633 people died and 6190 heart disease-related events occurred. After adjusting for other factors that could influence the risk of illness or death over that period – such as diet, smoking and doing other forms of exercise – the researchers calculated that the optimal number of steps per day is between 9000 and 10,000, with the benefits then starting to tail off.

PATRICK ZACHMANN/MAGNUM PHOTOS

Many people try to fit 10,000 steps into their normal day-to-day lives

Taking this many steps was linked to a 39 per cent lower risk of dying during the follow-up period and a 21 per cent lower risk of a heart-related incident (*British Journal of Sports Medicine*, doi.org/mkkt).

"This paper helps the field take a great stride forward," says Dale Esliger at Loughborough University in the UK. "It does appear to support the notion that the originally non-evidence-based 10,000 steps target may indeed be about right."

However, he also says that wrist-worn accelerometers aren't always the best indicator of step count. ▮ CS-W

Technology

D-Wave claims it has achieved 'computational supremacy'

Matthew Sparkes

QUANTUM computers can now solve problems with real-world applications faster than any ordinary computer, suggesting they could be commercially viable, say researchers at quantum computing firm D-Wave. However, outside observers are more cautious.

It has long been hoped that quantum computers will be able to perform some tasks that are impractical or impossible on even the best supercomputers. Google was the first to demonstrate this "quantum supremacy" in 2019, but only for a rather contrived test with no practical use. Earlier this month, Google launched a $5 million competition to find real-world applications for its machines.

Now, D-Wave says it has achieved a real-world application of its own, claiming that its Advantage quantum computer and a prototype Advantage2 machine can calculate transverse field Ising model problems – a quantum version of a mathematical approximation of how matter behaves when changing state, such as from a liquid to a gas. It calls this milestone "computational supremacy", a step up from mere quantum supremacy.

In a paper setting out the work, the team estimates that the world's most powerful classical computer, Frontier, would require millions of years to solve these problems and would need more electricity than is produced globally each year (arXiv, doi.org/mkw5).

D-Wave declined *New Scientist*'s request for an interview and said it couldn't comment until the research was peer-reviewed. But its CEO, Alan Baratz, tweeted: "These problems cannot be solved by classical computers, full stop."

LUKAS SCHULZE/GETTY IMAGES

A D-Wave Advantage quantum computer in Julich, Germany

D-Wave's "quantum annealing" computers differ from machines produced by Google and many others in the industry. They have been criticised as only being able to solve certain classes of optimisation problem, rather than serving as general quantum computers capable of tackling any problem.

Yuri Pashkin at Lancaster University, UK, prefers to call D-Wave's machine a "simulator"

"These problems cannot be solved by classical computers, full stop"

of a quantum system, but he says it is fair for the firm to claim computational supremacy – within a very narrow scenario. "It's a very specific task and it's not a universal computer," he says. "You can't use it for anything else.""

While the Ising model problems have applications in physics, a range of other optimisation problems that would be useful for the logistics and finance industries can be represented in a similar way. But Pashkin says it is unclear how many practical problems D-Wave's systems can compute.

Josh Nunn at rival firm Orca Computing says the D-Wave results appear strong and suggest that so-called noisy intermediate-scale quantum computers – like those made by D-Wave and Orca – can already be useful for certain tasks.

"If you can already start making machines that are useful to enterprise and industry... it changes the commercial proposition," says Nunn. But he also warns that the milestone might not stand for long. Classical computer scientists have often managed to improve algorithms to leapfrog quantum computers again and move back into the lead when it comes to computational supremacy, he says. ▮

Food science

Hybrid moulds herald unusual blue cheeses

James Woodford

FIVE new varieties of *Penicillium roqueforti*, the fungus used to make blue cheese, have been created, which could secure the future of Stilton and Roquefort and let us create interesting new cheeses.

***P. roqueforti* is used to produce blue cheese's distinctive coloured veins and flavour. Until now, strains of the bacterium could be grouped into four populations, two for making cheese and two found in silage, timber and spoiled food.**

The two blue cheese populations, known as Roquefort and non-Roquefort, are both experiencing genetic bottlenecks. They primarily reproduce asexually, which means harmful mutations can accumulate in the population. Without new fungus varieties, the production of blue cheese may end up in trouble, says Tatiana Giraud at Paris-Saclay University. "Without diversity, there is no possibility to adapt."

So Giraud and her colleagues have created five new crosses with parents from both the cheese and non-cheese strains of *P. roqueforti*.

She says they have properties that could enable new cheese styles. "We can produce new types of products, more or less blue, milder or stronger."

"Producers could almost dial up their list of desirable characteristics," says Donald Gardiner at the University of Queensland, Australia. "More or less colour, faster or slower growth rate, acidity differences."

Existing *P. roqueforti* strains can be used to produce some medically useful compounds, such as mycophenolic acid, an immunosuppressant used to prevent rejection of tranplanted organs, and the anti-tumour compound andrastin A. The study showed that the new crosses also had the potential to increase the production of these compounds (bioRxiv, doi.org/mkww). ▮

Health

Weight-loss pill could beat Wegovy

People taking the oral tablet amycretin lost 13 per cent of their body weight over three months, more than twice that seen with Wegovy, finds **Clare Wilson**

AN EXPERIMENTAL pill looks set to cause more weight loss than existing injectable treatments such as Ozempic, Wegovy and Mounjaro, based on early trial results reported on 7 March.

The medicine, called amycretin, led people to lose 13 per cent of their weight over three months, more than twice the amount seen with Ozempic and Wegovy specifically.

"This approach seems to be a little bit more exciting, from the limited data that we have," says Daniel Drucker at the University of Toronto in Canada.

The results are from a placebo-controlled trial lasting three months, so it is too soon to know how amycretin stacks up against the other medicines for long-term effectiveness and safety, says Drucker, who wasn't involved in the trial but has consulted for the drug's manufacturer Novo Nordisk and other pharmaceutical companies.

The diabetes drug Ozempic and the weight-loss drug Wegovy are two brand names for the compound semaglutide. They work by mimicking a gut hormone called GLP-1 that is normally released after eating. This makes people feel full, reduces their appetite and boosts the release of the blood sugar-regulating hormone insulin.

Semaglutide leads to the loss of about 15 per cent of body weight after it has been taken for one year, although weight then plateaus and people need to continue the injections long term or it tends to creep back up.

Another weight-loss injection called Mounjaro, also known as tirzepatide or Zepbound, was launched last year. This mimics GLP-1 and another gut hormone called GIP. Mounjaro seems to lead to people losing about 21 per cent of their weight over the first year and five months of use, before weight loss plateaus.

Amycretin, however, mimics GLP-1 and a different hormone called amylin, which seems to make it more potent still – at least over the first three months of treatment.

"Being available in tablet form would be a great advantage for people who don't like injections"

People taking amycretin lost 13 per cent of their weight in this period, Novo Nordisk announced on 7 March. Those taking placebo pills lost 1 per cent. This is more than the equivalent figures for Wegovy and Ozempic, of 6 per cent, and for Mounjaro, of about 7.5 per cent.

However, we can only know for sure how the drugs measure up long term when they are compared under exactly the same circumstances in a single study, says Drucker. "These are not head-to-head trials."

Another caveat is that medicines that work by mimicking GLP-1 have been used for more than a decade to treat type 2 diabetes and so their safety profile is well understood, which isn't the case for an amylin mimic.

Novo Nordisk has also said that amycretin's side effects were similar to those of Wegovy, which tend to be nausea, vomiting and diarrhoea, especially for people who increase the dose too quickly.

Being available in tablet form would be a great advantage for people who don't like injections, says Daniel Chancellor at global pharmaceutical business analyst Citeline. "An oral pill is very attractive." ▮

Zoology

Amphibian feeds hatchlings 'milk' from its rear end

A WORM-LIKE creature that secretes a kind of milk for its hatchlings is the first known example of an amphibian feeding its young in this way.

Ringed caecilians (*Siphonops annulatus*) are egg-laying amphibians that can be found in dark, moist forest floors across South America. Their deep blue cylindrical bodies reach up to 45 centimetres in length.

The amphibians are born with spoon-shaped teeth. They use these to feed on their mother's skin, which is rich in lipids and proteins.

"But this skin feeding only happens once a week," says Carlos Jared at the Butantan Institute in São Paulo, Brazil. That isn't enough food to sustain the rate at which the young develop, he says.

To find out where the extra nutrition comes from, Jared and his colleagues recorded videos of 16 female ringed caecilians and their offspring. The hatchlings wriggled around the end of their mother's body several times a day, often nibbling and sticking their heads into a posterior orifice, known as a vent.

CARLOS JARED

A female ringed caecilian (*Siphonops annulatus*) with its brood

The footage showed small drops of a milk-like substance on the vent's opening, which suggests that the young were feeding on it. Analysis of the milk revealed that it contained lipids and carbohydrates, which the team says give the hatchlings the energy to grow.

The team also found that touch and sound signals from the hatchlings stimulated milk production in glands within the mother's oviduct, or fallopian tube (*Science*, doi.org/gtk4f9).

Some caecilians that give birth to live young secrete nutritious fluids for fetuses inside the mother's body, but this is the first time amphibians have been found to produce fluid to feed young outside the body. ▮

Chen Ly

Cancer

Light and sound therapy may prevent 'chemo brain'

Clare Wilson

AN EXPERIMENTAL treatment for Alzheimer's disease that involves flickering lights and low-pitched sound might also help prevent cognitive problems after cancer treatment, a study in mice suggests.

For Alzheimer's disease, the method has been shown to ease people's memory and concentration problems in small trials, but it is still being investigated in larger studies.

The lights flicker 40 times a second, or 40 hertz, with the sound also having a frequency of 40 Hz. This frequency was selected because people with Alzheimer's have a lower intensity of 40 Hz brainwaves, which are linked with memory processing. Recent research suggests such waves bring brain benefits, including increasing the activity of immune cells and boosting its drainage system.

Curious about whether the approach might also help people who get memory and concentration problems after chemotherapy, sometimes called chemo brain, Li-Huei Tsai at the Massachusetts Institute of Technology and her colleagues turned to mice.

They found that cancer-free mice exposed to the lights and sounds for 1 hour a day while being dosed with the chemotherapy drug cisplatin showed less of a decline in mental sharpness – assessed by seeing how much interest they showed in novel or familiar objects – than those that just had chemotherapy.

The therapy also lowered brain inflammation, reduced DNA damage and lessened the loss of myelin, the insulation around nerve cell fibres (*Science Translational Medicine*, doi.org/mkkw).

Nazanin Derakhshan at the University of Reading, UK, says the method needs to be tested in people. If the treatment reduces cell death in the brain, it could promote the survival of cancer cells there, she says. ▮

Animal behaviour

Asian elephants seen burying their dead for the first time

Jeanne Timmons

PARVEEN KASWAN AND AKASHDEEP ROY

An elephant pulling a dead calf on a tea estate in north Bengal, India

ASIAN elephants have been documented burying the bodies of their calves, in the first scientific report of such behaviour in this species.

Five buried calves were discovered in drainage ditches on tea-growing estates in north Bengal, India, all with their feet and legs protruding from the ground.

Footprints and dung of various sizes indicate that herd members of all ages contributed to each burial. Night guards at the estates reported loud elephant vocalisations, sometimes lasting as long as 30 to 40 minutes, before the herd left the area.

Akashdeep Roy at the Indian Institute of Science Education and Research in Pune and Parveen Kaswan at the Indian Forest Service suggest that these trumpeting sounds may signify mourning and that the herds showed "helping and compassionate behaviour" during the burials.

"Calf burials are extremely rare events in nature," says Roy.

They were surprised that the calves were buried feet up, but if the herd collectively buried each calf, this is the easiest way to place the carcass into a drainage ditch, says Roy. As social animals, it may be most important to the elephants to bury the calf's head, he says.

The calves' bodies were later exhumed and examined. They ranged in age from 3 months to a year old, and some were malnourished and had infections. Bruising along each calf's back suggests they were dragged or carried long distances to the burial sites (*Journal of Threatened Taxa*, doi.org/mkkv).

5

The number of elephant calves that were found buried

African bush elephants (*Loxodonta africana*) have been observed covering dead bodies with vegetation and returning to these locations later. However, the Asian elephants (*Elephas maximus*) in this study generally avoided returning to the burial sites and used alternative pathways instead.

"These observations offer impressive evidence of the social complexities of elephants," says Chase LaDue at the Oklahoma City Zoo and Botanical Garden. "Others have noted that elephants appear to behave in unique ways towards their deceased relatives, [but] this paper is the first to describe what appears to be methodical and deliberate burial of elephant calves after they have been carried to the burial site."

But LaDue says: "We must be careful in how we interpret these results, especially as the mental and emotional lives of elephants are still largely mysterious to us."

He isn't convinced that the positioning of the calves was intentional. "I could envision elephants pushing a dead calf into a narrow ditch and, given the awkward shape and weight distribution, the calf landing on their back with the feet in the air," he says. "Then, because of the shallow depth of the ditch, the feet are left unburied, not because they deliberately buried the head."

The land in which elephants once roamed freely is shrinking as humans expand, especially in India, the world's most populous country. Only about 22 per cent of the land elephants use is within protected areas.

"Understanding how elephants behave and respond to rapid changes in human-dominated landscapes may help us develop conservation strategies that promote the coexistence of people and elephants," says LaDue. ▮

Geology

Anthropocene Epoch rejected

Scientists surprised by refusal of a proposal for a geological epoch defined by human activity

Chen Ly

EFFORTS to put the Anthropocene on the geological timescale have fallen at the first hurdle, shocking members of the consulting scientific body, who only learned of the official decision when it was publicised. A panel voted down the proposal 12 to 4, declining to define a new epoch based on the planetary changes brought about by humans.

The current epoch is the Holocene, which began about 11,700 years ago and is marked by the progress of humans. However, some academics argue that more recent changes to the planet due to our activity, such as from nuclear weapons, are enough to herald a new epoch: the Anthropocene.

Last July, the Anthropocene Working Group (AWG) decided that Crawford Lake in Canada was the site that presented the best geological evidence for the new potential epoch. Radioactive isotopes dated to the 1950s have been preserved in the lake bed. In October, the AWG submitted a formal proposal to its parent body, the Subcommission on Quaternary Stratigraphy (SQS), for the first round of voting.

CORBIS HISTORICAL VIA GETTY IMAGES

Nuclear weapons, like the 1957 Priscilla explosion in Nevada, leave a lasting effect

Now, the results are in. According to a report in *The New York Times*, published on 5 March, 12 of the SQS voting members opposed the proposal, four supported it and two abstained.

"The [*New York Times*] article was unexpected coming out this morning, as we had not received official confirmation directly from the Secretary of SQS," said AWG members Simon Turner at University College London and Colin Waters at the University of Leicester, UK, in an email to *New Scientist* on 5 March. On the result, Turner and Waters said: "Clearly this is very disappointing given the huge contribution by AWG to develop our case."

On 6 March, the SQS released a statement saying that the details reported by *The New York Times* were "unverified" and that the vote took place in breach of the official processes set by its parent body, the International Commission on Stratigraphy.

As a result, the chair of the SQS, Jan Zalasiewicz at the University of Leicester, UK, has requested an inquiry to begin the procedure to annul the "putative" vote.

There are a few reasons why the proposal was rejected, says Mike Walker at the University of Wales, Lampeter, in the UK, who is a voting member of the SQS. Human impacts extend far back beyond the proposed start data of the Anthropocene, including the colonisation of the Americas and the industrial revolution.

"The time span of the proposed Anthropocene is no more than 75 years – a single human lifetime," says Walker. "This does not fit comfortably into the geological timescale, where units typically span thousands, tens of thousands or millions of years."

"The time span of the proposed Anthropocene is no more than 75 years – a single human lifetime"

Turner and Waters disagree with the decision, saying the evidence indicates that the Anthropocene, though short for now, is "of sufficient scale and importance to be represented on the Geological Time Scale".

"It was a shock to some," says Kim Cohen at Utrecht University in the Netherlands, also on the SQS voting committee. But even though the Anthropocene won't be on geological charts, it will still be a useful, significant concept, he says. ▮

Marine biology

Clownfish have a sugary way to avoid anemone stings

THE secret is in the snot. Chemical changes in the mucus that coats a clownfish's body seem to blunt the sting of anemones.

How exactly clownfish, also known as anemonefish, are protected from the stings of the anemones they form a symbiotic relationship with has long been a mystery, says Karen Burke da Silva at Flinders University in Australia.

To investigate, she and her colleagues raised orange clownfish (*Amphiprion percula*) and bubble-tip anemones (*Entacmaea quadricolor*) in the lab. Some of the fish and anemones were paired together, while others lived separately. The team took mucus samples from the fish at various times before and after they acclimatised to their anemones, then put the mucus on microscope slides and pressed it onto an anemone's tentacle.

Anemones sting by explosively firing microscopic, venomous harpoons from stinging cells called nematocytes. The researchers counted how many nematocytes fired after mucus treatments and found that mucus from anemones' clownfish partners – but not from unacquainted fish – reduced firing.

GARY BELL/OCEANWIDE/NATUREPL.COM

Clownfish form a mutually advantageous relationship with anemones

To figure out why, the team looked at how the mucus changed over time. Three weeks into a symbiotic partnership, the mucus's chemical profile had shifted substantially. In particular, the concentrations of seven types of glycans – chains of sugars that attach to proteins – had changed (bioRxiv, doi.org/mkmg). Getting rid of glycans or tweaking them may suppress the firing of nematocytes, says Burke da Silva.

Other strategies could also be at play. The glycan change is slow and reverts within a day of partners being split up. So the fish may use an unknown chemical strategy to get initial access to an anemone. ▮

Jake Buehler

Astronomy

Bizarre galaxy died very young but may come back to life

Leah Crane

A STRANGE galaxy in the early universe lived fast and died young. It is the most distant "dead" galaxy – meaning it is no longer forming new stars – ever spotted.

The galaxy, JADES-GS+53.15508-27.80178, was discovered in 2010, but little was known about it. Now, Francesco D'Eugenio at the University of Cambridge and his colleagues have observed it with the James Webb Space Telescope and think that its star formation has quenched.

This is unusual because the galaxy is so far away that we see it as it was just 700 million years after the big bang. "There is lots of gas in the early universe, and gas fuels star formation. So seeing a dead galaxy at such an early epoch means that there must be something actively preventing it from forming stars," says D'Eugenio. "That is very surprising."

The researchers estimate that the galaxy's star-forming activity lasted between 10 million and 50 million years, a very short time compared with otherwise similar galaxies near it (*Nature*, doi.org/mkhd). It isn't clear why star formation there ceased so fast, but there are two possible explanations.

The first idea relates to when stars form, when they create huge amounts of radiation and powerful winds before they explode. All this turbulence could have blown the gas out of the galaxy, stopping star formation. The other idea is that an active black hole at the galaxy's centre similarly produced strong winds that blasted the gas away. If either process occurred, it must have unfolded faster in the early universe than it does today.

Yet the galaxy might still come back to life. "Galaxies, especially at these early epochs, may rejuvenate and start forming stars again – we don't know what will happen," says D'Eugenio. ▮

Archaeology

Ukraine may be first place in Europe inhabited by early humans

Michael Le Page

MOLECULAR dating has revealed that an area in Ukraine was occupied by humans 1.4 million years ago, making it one of the oldest hominin sites in Europe and possibly the oldest.

The site, at Korolevo in western Ukraine, has been studied since the 1970s. A large number of stone tools have been found buried in layers of sediment beside an outcrop of volcanic rock suitable to be made into tools.

"This was like a magnet for bringing the people there, and they were camping nearby," says Roman Garba at the Czech Academy of Sciences in Prague.

No bones have been found as the soil is too acidic to preserve them, he says, but it is assumed that the hominins were *Homo erectus*, a species that evolved about 2 million years ago and spread from Africa to Europe and Asia.

While it has been clear that early hominins were present at the Korolevo site repeatedly over hundreds of thousands of years, we haven't known exactly when they were there. Garba's team has now dated the oldest layer containing tools to 1.4 million years ago, using a technique called cosmogenic nuclide dating.

This relies on cosmic rays that are so energetic that they can split the nuclei of atoms and generate unusual isotopes. However, these isotopes form only on exposed areas, because the cosmic rays don't penetrate far into solid objects.

1.4m

Age of the tool-containing layer in Korolevo, Ukraine, in years

Once objects are buried, radioactive isotopes generated by cosmic rays decay into other isotopes, allowing the time of burial to be determined.

Another early hominin site, in Dmanisi in Georgia, has been dated to 1.7 million years ago, while other sites in France and Spain are around 1.2 million years old. This suggests that early humans moved from Africa through Georgia and into Ukraine, then west into the rest of Europe, says Garba, although it is possible that some crossed the Bosphorus Strait in Turkey.

It has been suggested that some hominins crossed the Gibraltar Strait to reach Spain when sea levels were lower than present, then moved east into the rest of Europe, but there is no evidence for this, says Garba.

While part of Georgia is geographically in Europe, the Dmanisi site is in Asia, says Garba. So he and his team regard Korolevo as the oldest reliably dated human site in Europe (*Nature*, doi.org/mkhc).

"I agree that the new age estimates are important, and they support the idea of an early east-west dispersal," says Chris Stringer at the Natural History Museum in London. But this was already apparent as four other sites in western Europe have already been dated to some 1.4 million years ago, he says.

Garba says that while it is possible the other sites are as old, their dating is questionable. "We can't be as sure about them," he says. "They are not secure or not robust."

"I respectfully disagree," says Stringer. ▮

ROMAN GARBA

Korolevo quarry in Ukraine, one of the oldest hominin sites in Europe

Zoology

Bees teach each other puzzle solving

BUMBLEBEES can show each other how to solve a puzzle too hard for them to crack alone. The finding suggests these insects might use advanced social learning that has previously only been demonstrated in humans.

Alice Bridges at Queen Mary University of London and her colleagues presented bumblebees with a puzzle box that required them to manoeuvre a blue lever and then a red one in sequence to access a sugary treat. On their own, no bees from three different colonies could figure it out.

Then, the researchers taught nine of the bumblebees the key. When reintroduced in the colony, the upskilled bees passed their new knowledge onto five other bees that had never seen the puzzle box before (*Nature*, doi.org/mkhf). **Sofia Quaglia**

SERGIO AZENHA/ALAMY

Astronomy

Crystal effect keeps stars looking young

SOME white dwarfs may be frozen in time by floating crystals, looking younger than they are.

White dwarfs form when stars burn through their fuel and blow off their outer layers. The hot core then cools and eventually freezes over. But in 2019, astronomers found that some massive white dwarfs maintain their temperature for billions of years rather than cooling consistently.

Simon Blouin at the University of Victoria in Canada and his colleagues have now simulated how this happens. They say the culprit could be the effect of freezing fluids with multiple different compositions, in which heavier elements get pushed out of the ice crystals as they form (*Nature*, doi.org/mkhj). This generates heat, which keeps the white dwarf warm, making it hard to be sure of its age. **Leah Crane**

Health

Make-up may damage skin health during exercise

WEARING foundation while exercising may affect skin health by stopping pores from opening and releasing sebum, which plays a role in keeping skin healthy.

Sukho Lee at Texas A&M University-San Antonio and his colleagues recruited 43 college students, 20 men and 23 women. The participants washed their faces with a cleanser and then the researchers measured skin variables on different areas of their faces, including pore size and sebum production.

Next, a single layer of foundation was applied to part of the participants' faces, either their foreheads or cheeks, depending on which they preferred.

The participants then ran for 20 minutes on a treadmill. After the workout, the researchers repeated the skin measurements and found that there was less sebum on the areas with foundation than in the areas that weren't covered in make-up.

The size of the participants' pores increased in the areas without foundation, but there were no meaningful change to those in the made-up areas (*Journal of Cosmetic Dermatology*, doi.org/mkhh). This suggests the foundation restricted pores from naturally enlarging during exercise, preventing the release of sebum and sweat, which moisturises and cools skin.

The optimal amount of sebum is unclear, with too much being linked to acne and too little causing skin irritation.

Wearing foundation may not have a big effect in relatively short workouts, but we don't yet know what the impact would be for longer exercise routines, says Lee. Sara Novak

Really brief

CHARLES MANN/GETTY IMAGES

Mutation makes Labradors hungrier

Two dog breeds, Labradors and flat-coated retrievers, may be prone to becoming overweight because they have a mutation that makes them hungrier between meals and lowers their metabolic rate. The mutation affects a gene called *POMC* (*Science Advances*, doi.org/mkhk).

US coastal cities face more floods

Sea levels are rising faster than expected in coastal cities in the US, largely due to land sinking as a result of the extraction of water and fossil fuels. This means by 2050, up to 518,000 extra people in these areas could be at risk of significant flooding, if defences aren't put in place (*Nature*, doi.org/mkhm).

Microplastics linked to heart attack risk

People with artery plaques containing microplastics are more likely to have a heart attack or stroke than those with plastic-free plaques. This suggests that the fragments of plastic, which can make their way into us through food, water and the air we breathe, may contribute to heart disease (*NEJM*, doi.org/mkhn).

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Views

The columnist
Does biodiversity offsetting work, asks **Graham Lawton** p22

Aperture
Saving *Rafflesia*, the world's largest flowers p24

Letters
The real question is why aren't we all cannibals? p26

Culture
How memory shapes our world and is key to creativity p28

Culture columnist
Emily H. Wilson tackles a novel about a sentient sex bot p30

Comment

The age of deception

Disinformation is far older than humans. Lessons from evolutionary biology can help defend against it today, says **Jonathan R. Goodman**

THE recent "Willy's Chocolate Experience" in Glasgow, UK, brought children to tears, angered parents and was a source of mirth for those who read about it. After seeing online advertising for an apparently lavish event, people paid up to £35 each to attend. But it wasn't as promised: instead of wondrous creations and an abundance of chocolate, families arrived at a mostly abandoned warehouse featuring a sad-looking bouncy castle and confused actors.

When news networks looked into the event, it emerged that the marketing materials – and the actors' scripts – were produced by artificial intelligence. The advertising created the impression that the experience would be worth the money, leading to a difficult question: in the era of AI, how can we tell whether we are being tricked?

Misleading ads are just one example of a veracity problem now endemic in our digitalised world. Yet even as deception grows more sophisticated, countermeasures are being developed: the BBC is trialling a tool from Intel known as "Fakecatcher" that analyses changes in facial blood flow to detect, for example, AI-generated ads that may feature a famous actor who has had nothing to do with the product.

There is an arms race going on in the digital world. But the competition between deception and honesty is as old as life on Earth. Understanding that evolutionary conflict can help us beat those who aim to lie to us.

SIMONE ROTELLA

Disinformation certainly predates the existence of humans. Cancer cells, for example, trick the immune system into treating them as a normal part of the body, rendering white blood cells useless against them. The body can't eliminate rogues if it can't tell friend from foe.

We see disinformation strategies among animals, too. Cuckoos lay their eggs in the nests of other birds. The foster parents are then deceived into raising the young of others at the expense of their own.

More complex are cases where primates seem to intentionally communicate false information to deceive. One study showed that wild tufted capuchin monkeys may shriek as though a predator is nearby to trick their fellow primates into running away from food. They then take the food for themselves – using, like a cancer cell or a cuckoo, disinformation to further their goals.

This links to what is known in biology as the Red Queen hypothesis. Derived in spirit from *Alice in Wonderland*, this effect refers to a case where two organisms compete to outmanoeuver each other. Bodies compete with cancers. Cuckoos compete with host birds. Primates compete with each other. In each clash, a new strategy by one party forces the other to adapt – or face elimination in the cold game of natural selection.

Disinformation today is the cultural equivalent, a more complex version of the false monkey shrieks. The only difference is the level of sophistication and the number of people involved.

The good news is that we know enough about evolutionary thinking to predict which steps bad actors will take next. We do this already with cancer: we have novel ways to lure it into evolving a weakness that we then exploit, a process called "evolutionary trapping". Similarly, we know someone will try to outwit the tools being developed to counter deepfakes. If Intel's tech is based on blood flow, we can predict what the next form of deepfake will look like, then pre-empt it. And so on.

Evolutionary biology in part describes ancient games of dishonesty and betrayal. We need to use our understanding of arms races to make traps of our own – disinformation traps. Armed with knowledge, we can go to war.

Jonathan R. Goodman is a research associate at Cambridge Public Health, UK

No planet B

Swap flop

Swap flop Biodiversity offsetting is a hugely contentious issue in conservation. Does it really work to destroy nature in one place, but preserve it elsewhere, asks **Graham Lawton**

Graham Lawton is a staff writer at *New Scientist* and author of *Mustn't Grumble: The surprising science of everyday ailments*. You can follow him @grahamlawton

Graham's week

What I'm reading
What Just Happened?! Dispatches from turbulent times *by* The Guardian*'s brilliant and hilarious columnist Marina Hyde.*

What I'm watching
I just got Sky Sports on my TV. So, sports.

What I'm working on
I am back on the biomed beat.

This column appears monthly. Up next week: Annalee Newitz

I LIVE close to Holloway Prison in north London, a former women's jail. It closed in 2016 and is currently a demolition site being readied for flats. Over the fence, I can see huge piles of rubble – and a single magnificent plane tree in the middle of what will become a park. I am glad the developers didn't raze it to the ground along with all the others.

The work started in 2019, but if it had happened more recently, all the trees would probably have stayed in place, because the site would be subject to a new law in England called biodiversity net gain. This forces developers to create 10 per cent more wildlife habitat than they destroy in the process of developing a site. The law came into force last month and is "one of the world's most ambitious ecological compensation policies", according to Sophus zu Ermgassen at the University of Oxford.

The law is explicitly designed to stop development projects from doing yet more damage to nature, and is much needed. Infrastructure projects are one of the biggest threats to global biodiversity, and biodiversity loss is one of the biggest threats to having a liveable planet.

Every development in England should now boost the country's heavily denuded natural capital. That gain must be maintained for 30 years after the development is completed. This all sounds very positive, but the law has its flaws, not least that it relies on one of conservation's most contentious issues: biodiversity offsetting.

The concept of offsetting is already familiar for carbon, where activities that emit greenhouse gases can be compensated for elsewhere, such as by planting trees. That is sound in principle, but has multiple problems in practice. Biodiversity offsetting is even more problematic.

Like carbon offsetting, the idea is that activities that destroy biodiversity in one place can be offset by preserving or enhancing it elsewhere. To be clear, that is the last resort in what conservation biologists call the mitigation hierarchy. First, you should avoid destroying biodiversity. Next, reduce unavoidable impacts. Third, make good on site by enhancing what remains or restoring what has been lost. Only then is offsetting required, to make up the gap. But there will be gaps, so it will be needed.

"A new law in England requires developers to create 10 per cent more wildlife habitat than they destroy"

That opens the door to fudge. Measuring biodiversity is notoriously difficult. The new law sets out a way to do it, called the statutory biodiversity metric. This explains how to assess the size, type and quality of the habitat and convert it into "standardised biodiversity units". However many units there were before the development starts, there must be 10 per cent more afterwards.

You may already have spotted the loopholes. Say a site contains a rare habitat worth 100 units. As long as there are 110 units afterwards, the developer has discharged its obligation, even if it is 110 units of a totally different habitat. The offsetting element only enlarges the loophole. Can 100 units in one location really be replaced by 110 somewhere else? This is a problem of "fungibility" – whether one type of habitat is directly interchangeable for another.

There are other problems too. The Australian state of Victoria has a biodiversity offsetting programme that allows companies to compensate for destruction by buying credits from nature-positive landowners elsewhere. Again, good in principle, but there is scant evidence the system has made biodiversity gains that wouldn't have happened anyway, according to research by zu Ermgassen.

These problems are writ large in the burgeoning international market for biodiversity offsets. This is envisaged to work like the carbon market, with destructive industries voluntarily buying biodiversity offsets, or credits, to atone for their sins against nature.

According to Brian O'Donnell, director of Campaign for Nature, governments increasingly see offsetting as a nifty way to bridge the estimated $700 billion annual funding gap between what is available for biodiversity conservation and what is needed to meet the goals of the 2022 Kunming-Montreal Global Biodiversity Framework.

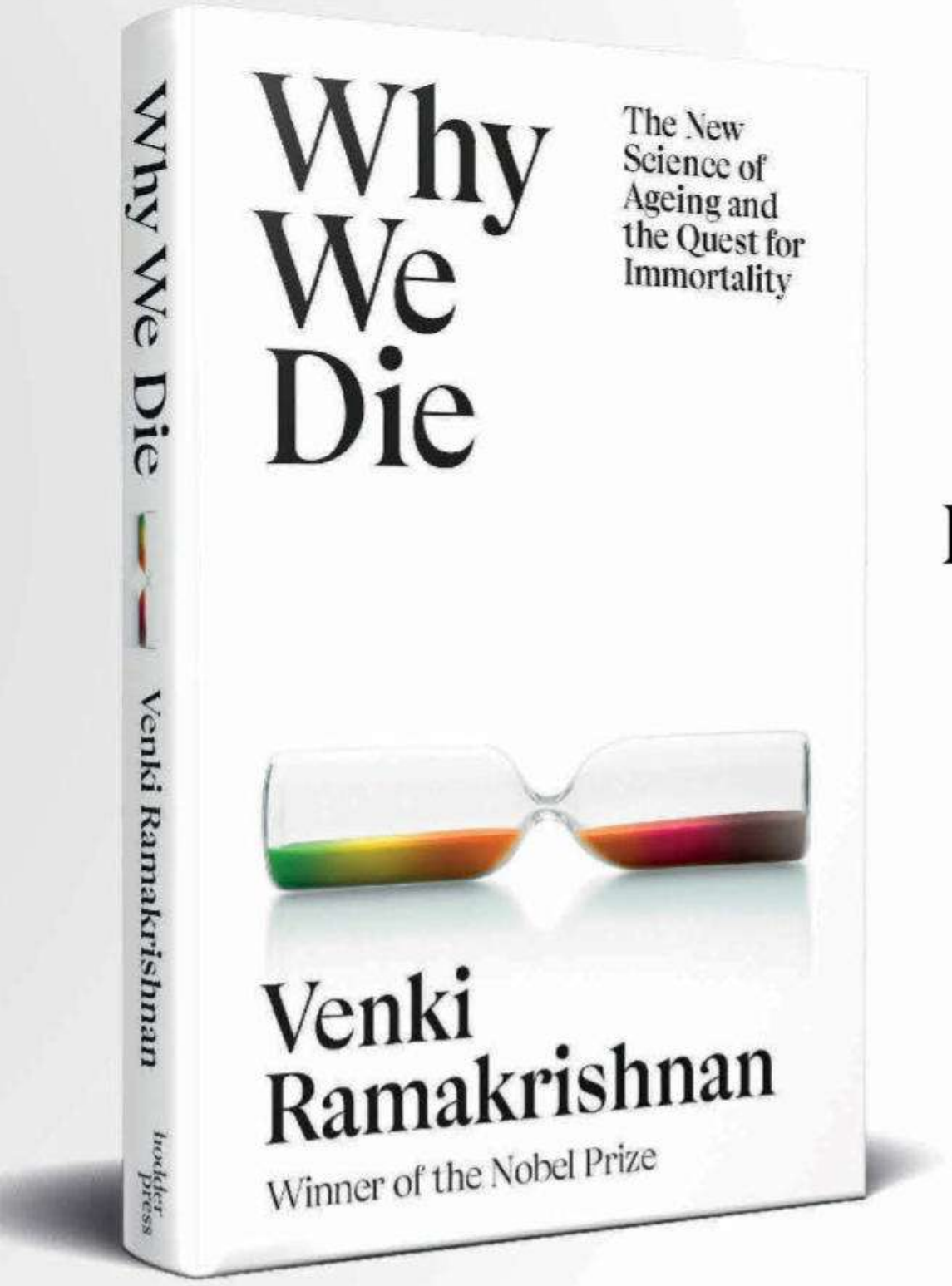
This is "magical thinking", says O'Donnell's colleague, Mark Opel. It will take at least a decade for the market to mature, which is too long, and it will provide only a fraction of what is needed. It also invites greenwashing. "We feel this approach is deeply flawed," says O'Donnell.

The only credible way to bridge the gap is for governments to step in and force companies to act, through carrots or sticks. In that respect, England's new law is a step in the right direction. But, ultimately, biodiversity offsetting is doomed to failure because of non-fungibility. "Biodiversity is infinitely complex," says Opel. "It's not fungible." ▮

‘A must-read’
Stephen Fry

‘Spectacular’
Chris van Tulleken

‘Utterly fascinating’
Bill Bryson



At some point, everyone dies.

But have you ever wondered why?

And can we do anything about it?

From the Nobel Prize-winner & former president of the Royal Society

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COURTESY OF CHRIS THOROGOOD

Clockwise from above: Chris Thorogood, Freddie Chavez, Adriane Tobias and Pastor Malabrigo Jr with their *Rafflesia* graft in the Sierra Madre mountains in the Philippines; *Rafflesia panchoana* on Mount Kemalugong in the Philippines; a *Rafflesia* relative, *Rhizanthes deceptor*, in the hill forests of Bengkulu, Sumatra; a view of Bengkulu; showing the size of *Rafflesia arnoldii* in south Bengkulu

Blooming huge

Photographer **Chris Thorogood**

RAFFLESIA is a parasitic plant that spends most of its life cycle within its host, a tropical vine, emerging only to bloom. Its flowers are the largest in the world, spanning up to a metre. Despite this, little is known about its life cycle, and it is almost impossible to grow.

Half of the *Rafflesia* species known to science were described in the past two decades, yet most have since come close to extinction. This is a plant in peril. On a recent trip in the Philippines, I saw a population decimated to make way for crops. As is often the case, a smallholder farmer was responsible – somebody just trying to make ends meet.

What is the solution? Protecting habitats is the best safeguard. But this only works if we know where *Rafflesia* occurs in the first place. Often, we don't. Local community action groups are crucial in this respect to monitor populations.

Beyond in-habitat conservation, most plants can be protected in seed banks or botanic gardens. But *Rafflesia* is an intractable parasite. The only botanic garden to have cultivated it successfully is in Bogor, Indonesia, where *Rafflesia*-infected vines are grafted onto new, uninfected rootstocks.

In 2022, my colleagues Pastor Malabrigo Jr and Adriane Tobias at the University of the Philippines Los Baños and I went to Bogor to learn how to grow the ungrowable. Back in the Philippines, we attempted the country's first ever *Rafflesia* propagation in a protected forest reserve. If our *R. panchoana* graft is successful, we will have created a template for propagating *Rafflesia* species on the brink of extinction in the Philippines.

Chris Thorogood is deputy director of the University of Oxford Botanic Garden and author of *Pathless Forest*

Editor's pick

On the many marvels of the human brain

24 February, p 32

From Geoff Harding, Sydney, Australia

In my experience of memory retention, it seems that, at the time this occurs, the brain – consciously or unconsciously – places a memory into a category with a rating of importance varying from "retention essential" to "almost discardable". Memories in the top category can be retained almost indefinitely, while those in the lowest, although probably not completely lost, need considerable stimulation to be retrieved.

However, the brain may rejig the category of memories. After a critical exam, for example, the memory of material in a subject of no further interest or importance will inevitably be relegated. Arguably, memory can therefore be enhanced by consciously assessing that some information or particular experience is important, so must be retained.

From Wai Wong, Melbourne, Australia

If thinking hard doesn't cause the brain to consume more energy, it doesn't make evolutionary sense that stress hormone levels rise when we need to concentrate. It is well known that elite chess players lose weight during tournaments. Even though the brain is only responsible for a small percentage of the extra calories burned, its extra energy requirement leads to stress that makes us burn more calories and feel exhausted.

From Stephanie Woodcock, Carnon Downs, Cornwall, UK

Jeffrey Lapides has discovered microbes in the brain seemingly implicated in Alzheimer's disease, an unexpected finding. Will this, and similar discoveries, signal a rethink about neurological and mental illnesses? Suspicions must arise that, overall, this may not be a benign microbiome, especially if pathogens are entering the brain.

We have medicines that act on some of these illnesses, so the question is whether current drugs are primarily acting on a microbial population and not necessarily on neural tissue or the psyche.

The real question is why aren't we all cannibals?

17 February, p 32

From Robert Law, Hong Kong, China

Your look at cannibalism mentioned that over the course of history, the practice "has been surprisingly common". In fact, this shouldn't be surprising at all. Cannibalism solves the food shortage problem and is environmentally friendly. So why not?

The real question should be: why did cannibalism all but vanish from the culture of *Homo sapiens*? Perhaps it was due to worries about being on the receiving end, which would make early society unstable, or the evolution of empathy.

More views on the ultra-processed food debate

24 February, p 21

From Howard Bobry, Port Townsend, Washington, US

Meat is the most "ultra-processed food". It is ultimately plants that have been chewed, digested, broken down, chemically altered, restructured as animal flesh, slaughtered, skinned, butchered and processed even further. Any factory processing of plant-based foods pales in comparison.

From Norman Fry, Newton Stewart, Dumfries and Galloway, UK

Dismissing concerns over ultra-processed food isn't so simple. We can't rely on cravings and appetite for health if we eat stuff that tells our body, by flavour and texture, that it has one nutritional profile while delivering an utterly different one. And what about the removal of essential and beneficial micronutrients when, for example, maize and palm oil are refined to sufficient blandness to be a bulk ingredient in everything from cake to low-fat mayonnaise? Also note today's dire health trends, not just in adults but children too. Surely our food is suspect and demands wider investigation?

Possible evolutionary origins of ADHD

2 March, p 9

From Martin Pitt, Leeds, UK

The gains from flitting between foraged food sources may not have promoted what we call ADHD. Instead, look at birds feeding on the ground. They don't hang around to pick up the food for a long time, but make frequent, random movements away to different places. This makes it harder for a stealthy predator to pounce accurately. A hominid carefully picking all the berries in a bush would be in danger.

Calling all members of the 100-kilometre-high club

24 February, p 29

From Sam Edge, Ringwood, Hampshire, UK

James Dinneen's review of *A City On Mars* was interesting. As its authors say, there has been, to our knowledge, no documented human sexual activity in space. However, given our species' predilections, I would be surprised if, with the person-hours racked up on past and present space stations, not to mention lunar and other orbital sojourns, nobody has experience of sex in space.

Tweak my dreams to stop leg ache please

17 February, p 36

From Susan Williams, Denver, Colorado, US

Here is a commercial application of dream engineering that I would welcome. Many people experience leg cramps at night, incidents where, in the middle of sleep, your leg turns into stone. It is very painful. Dream engineering might be able to implant the suggestion that our legs should remain relaxed during sleep. People would pay good money for this.

It may be a stretch to find evidence for string theory

17 February, p 40

From Alec Williams, Whitehead, County Antrim, UK

To find evidence to back string theory, Joseph Conlon suggests looking for certain primordial gravitational waves from very early in the universe. Presumably, these would be stretched as the universe expands, just as light waves are. Radiation we see as the cosmic microwave background was stretched many, many times from its original form. Gravitational waves from before the CMB would be stretched (and weakened) even more. Would they still be detectable?

Wishing for aviation's green revolution

24 February, p 12

From Richard Hind, Chapel Haddlesey, North Yorkshire, UK

I read your story on making jet fuel from carbon dioxide and it struck me that for this to succeed commercially, all it needs is a place that can generate lots of clean energy, has capital to invest in the infrastructure and has a need to replace an oil-dependent economy. I hope it really is that simple. ▮

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Surely you remember?

A smart, wide-ranging account of the purpose of memory and how it shapes our world shows how much there still is to learn, says **Helen Phillips**

Book
Why We Remember
Charan Ranganath
Faber

THERE are a lot of books about memory, so do we really need another? Why do we remember – surely we already know? Well, perhaps not as much as we thought. Whether you are into biology or not, if you only read one (more) book about memory, this is a smart choice.

Why We Remember: The science of memory and how it shapes us will leave you better informed and less distressed about forgetting why you wandered into a room. It will also have you itching to share: after all, what researchers now know about our memory, flaws and all, has far-reaching implications for law, medicine, education, social care, well-being and understanding who we are.

Charan Ranganath is director of the Memory and Plasticity Program at the University of California, Davis, and a respected researcher. In this book, he does what many experts can't: he tells a story that is thorough and entertaining, giving a sense of the enormity of the field and, most importantly, the issues raised.

That is no mean feat. Any account of how memory works quickly draws in most other aspects of brain function: our emotions, drives, attention, decisions, creativity, curiosity and social habits.

Even if you know the field really well, this excellent summary will bring you completely up to date and to the heart of how memory shapes our perceptions, interactions, choices and even our sense of identity.

You may already know that memory isn't particularly reliable and that we are, in fact, meant to forget most of what we learn or experience. But here we find a more nuanced view of what we do remember and why. As his book's title suggests, Ranganath argues that the key question isn't why we forget, but why we remember at all.

In exploring this, he demystifies how we see different types of memory – working memory for the information we keep only briefly in mind, our semantic memory for facts and our autobiographical memory for events – showing how the many facets of the memory system work together. And he ties it all together through the underlying brain anatomy.

The findings speak to why we tell stories, have intuition and are so susceptible to fake news. Ranganath also outlines why machine learning copes so badly with exceptions to rules or patterns, and how real brains get around many of these problems. He reveals how creativity is guided by memory, too, so there is no such thing as complete novelty – pertinent to recent court cases about hit songs.

Rather than seeing our memory as following a simple trajectory through life – from childhood "sponge" through maturity to older age and inevitable decline – Ranganath points out that it works differently at different life stages because that is how it evolved to work and how it needs to work.

The effects of age

Memory can function well as we get older, we might just need to work with it slightly differently. Couples who have spent a lifetime together, he writes, often help each other, combining their different memory strengths to find an answer. Sometimes the decline in memory in older people can be a result of undiagnosed depression, loss and loneliness.

And it isn't just as we age – the perceived flaws of memory are generally features of how it should work. It isn't meant to be easy to learn lists of abstract facts – memory didn't evolve to do that. It isn't there to recount the past at all, but to help us deal with the future.

That doesn't mean we can't improve it where we need to. We have to be active in creating a memory – and the book offers advice. Attention and intention are key to creating strong memories, but making errors is also important, says Ranganath, as he explains that our brains use past experiences to make predictions. When things don't go to plan, we must update our models of the world, so errors actually trigger learning. This speaks to the best way to educate children, by not just rewarding correct answers but allowing, even encouraging, mistakes.

Ranganath discusses false memories and has fascinating insights into the reconstructive nature of memory, arguing that memories are never either true or false, but always creations – as much a product of individual and collective experience as a record of an event. He also has dire warnings about what social media and the shift to continuous multitasking are doing to our ability to make memories. They undermine the all-important attention and intention. In many ways, he warns, we are forgetting how to remember.

I enjoyed *Why We Remember*, particularly the stimulating insights and issues raised – now I really want Ranganath to write a sequel: *And What Are We Going to Do About It?* ▮

ARTIST CLAIR/TETRA IMAGES, LLC/ALAMY

Is novelty in creativity actually a myth?

Helen Phillips is based in Devon, UK

Searching for wolves

Following the predators' return to Europe, what is stopping them from repopulating Britain, asks **Adam Weymouth**

JASPER DOEST/MINDEN PICTURES/ALAMY

Public anger over rewilding beavers or sea eagles leaves the grey wolf facing a long wait

leaving the country for towns and cities, wolves have now recolonised every country in mainland Europe under their own steam. But islands are a different proposition, and short of swimming the English Channel (no wolf has yet been recorded swimming further than 11 kilometres), reintroducing them here will take more persuasion.

Until Brexit, the UK was bound by the EU's Habitats Directive to consider the reintroduction of extirpated species. Today, the public furore in Britain over rewilding the beaver or sea eagle seems to suggest the return of the wolf is a long way off.

A farmer before he became a rewilder, Gow continues to work with livestock. As such, he bridges the gulf between conservationists and farmers better than most. Once, we killed our wolves to protect our sheep, but Gow doesn't believe that sheep have much of a future in Britain, propped up by subsidies as they are. He is bold, opinionated and a little eccentric, but the case he makes for the wolf doesn't seem eccentric at all. In showing how the history of Britain is entwined with that of wolves, what comes to seem unusual is their absence.

Many species will probably be reintroduced before the wolf, but wolves are important because they are among the most emotive of animals. They make us think about the violence we have inflicted on the natural world – and the possibility of doing something differently. In setting out the evidence for our long and terrible relationship with wolves, Gow's book goes some way towards creating a space for them again. ▮

Adam Weymouth is a writer based on the south-east coast of England

Book

Hunt for the Shadow Wolf
Derek Gow
Chelsea Green

EVER since 1995, when he got hold of his first water voles, Derek Gow has been plugging away with species reintroductions. He has released thousands of voles, along with dozens of beavers, all raised on the farm he has rewilded for decades in Devon, UK. Future plans include storks – white and black – and wild cats. Sceptical of official channels, and acutely aware of the paucity of the environment around us, he has decided to simply get on with it.

In his book *Hunt for the Shadow Wolf: The lost history of wolves in Britain and the myths and stories that surround them*, Gow tackles one of the toughest rewilding cases.

There are plenty of last wolf stories in Britain, many based more on myth and confusion than on fact. But the real history Gow lays bare from archives, museums and parish records is a past that seems predicated on hatred. He tells of hunting parties and bounties that drove wolves to extinction. He finds evidence for the poisons and pits used against them; for bait containing sprung steel that ruptured their guts; and reports of wolves that had their mouths sewn shut or that were hamstrung before being set upon by hounds.

Gow believes that wolves survived in Britain "well into the eighteenth century". This means there are plenty of trees alive today that would have been used as wolf scratching posts in their youth.

Britain was shaped by wolves. In Penrith, Gow visits an ancient stone enclosure built to shelter shepherds and their flocks at night. In a museum in Wales, he finds three wolf paws nailed to a board. On Sutherland's coast, he sees towers used as cemeteries so wolves wouldn't disinter the dead. As he picks through place names – Wolfhole, Wolfpits Farm, Wolf Crag, Howl Moor, Whelphill – they feel close enough to touch.

"In showing how the history of Britain is entwined with that of wolves, their absence comes to feel unusual"

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New Scientist *recommends*

Rowan Hooper
Podcast editor
London

You have until 7 April to catch Mat Collishaw's amazing **Petrichor** exhibition at the Royal Botanic Gardens, Kew, in London. His art is unlike anything I have ever seen, drawing on botany and evolutionary biology while mashing up old and modern techniques.

PETER MALLET

For example, to make his *Alluvion* series, Collishaw used artificial intelligence to generate images of flowers that resemble insects – a phenomenon known as Pouyannian mimicry, where flowers evolved to look like insects to attract other insects and get pollinated. He painted the results in the style of Dutch Golden Age artists.

I also loved *The Centrifugal Soul*, an extraordinary sculpture (pictured above) depicting hummingbirds feeding and bowerbirds displaying, all brought to life in strobe lights. And the immersive short *Even to the End* takes you to a stunning island paradise – before it turns to ashes.

So head to Kew and discover work that challenges us to think about our place in, and impact on, the world.

The sci-fi column

Becoming Annie Sierra Greer's sharp take on artificial intelligence and the morality of abusing sentience for our pleasure is politically timely and even funny, as a sex robot develops a real personality and sense of worth, says **Emily H. Wilson**

Emily H. Wilson is a former editor of *New Scientist*. *Gilgamesh*, the second novel in her *Sumerians* trilogy, is out later this year. You can find her at emilyhwilson.com, or follow her on X at @emilyhwilson and on Instagram at @emilyhwilson1

NIAZ MALEKNIA

Annie Bot is hard-coded to please her owner/partner

ANNIE BOT is the story of a robot who lives with her human owner, Doug, in a New York apartment. I opened the novel with low hopes, because the idea of a robot learning to be human, then chafing at its bonds, seemed a bit old hat. How wrong I was. Right from the first page, the book is coruscating, unexpected and subtle. I picked it up idly one evening and felt compelled to stay up very late to finish it.

Annie is a beautiful sex toy, designed to pass as human. There are telltale signs that she is artificial, however. She mostly keeps her temperature at 75°F (24°C) to save on battery; she has to warm herself up when Doug wants sex. She recharges herself through a charge point in one heel. She can make a show of eating and drinking to pass as a normal woman, but afterwards she vomits to avoid damage to her insides. When she goes for her regular maintenance check-ups, the technicians inspect her memory and health, but they also slim her down or make her breasts bigger, whatever Doug wants. We quickly understand that Annie has no rights at all.

Doug has set Annie to "cuddle bunny" mode, which makes her good at anticipating his sexual needs, but less good at cleaning his apartment. He also has her switched to "autodidactic" mode, which means she is sentient. Doug mostly likes her this way; it makes her less predictable. Of course, if he wants to flip the sentience switch off, get her memory wiped or just put her in a closet for weeks on end, he can do that any time.

"At Annie's maintenance check-ups, technicians also slim her or make her breasts bigger"

What makes the book unputdownable is that Annie Bot is a wonderful character. She is whole-hearted and innocent, but also a fast learner, super-curious, an enthusiastic liar and great fun to be with. And the fact that Doug can do anything he likes to her at any moment means that she is in at least low-level peril on an almost sentence-by-sentence basis. Poor Annie!

She is also a brilliantly unreliable narrator. Her programming means that she doesn't (initially) question her life in Doug's apartment. Nor does she object to having sex with Doug whenever he likes. Pleasing him is hard-coded into her and she suffers physical distress if he is angry with her.

Of course, you, the reader, may quickly learn to loathe Doug. I know I did! He is self-pitying, mean, hair-triggered and selfish, while also having a very high opinion of himself. He isn't irredeemable, perhaps, but he is certainly not great, despite being, in his own mind, the perfect owner-boyfriend for Annie. If things go wrong between them, he definitely believes he is the victim.

Interestingly, the story works well on a number of levels. It is obviously a very clever exploration of AI and the ethics of treating anything even vaguely sentient as a tool for your own pleasure. That makes it political and timely. It is also a very human novel about emotional abuse. At times, it offers quite a funny portrait of a terrible relationship, particularly when Doug and Annie see a couples therapist together. It is also the coming-of-age story of a young woman, albeit one who was born only two years ago and has a flap on her back for maintenance.

Sierra Greer, the novel's author, is an excellent writer, and I wasn't surprised to learn that this literary "debut" isn't really a debut. She has written several other books under another name.

Anyway, this is a delicious and thought-provoking book. Free the Annie Bots now! ▮

Book
Annie Bot
Sierra Greer
The Borough Press (UK), available now; Mariner Books (US), on sale 19 March

Emily also recommends...

Book
The Player of Games
Iain M. Banks
Hachette
For robots that are basically the opposite of Annie Bot, I recommend anything in Banks's Culture *series. No one does innocent-looking-drone-that-is-actually-lethal better. I think this book, by the way, is the best entry point to the series for new readers.*

HELP EXPLORE A NOVEL INTERACTIVE AI PARADIGM!

We need two talented and purposeful Post-Doctoral Research Assistants to help explore a new paradigm for interactive Artificial Intelligence. You'll join Professor Matt Jones of the Enhancing People's Interactions and Collaborations (EPIC) Centre at the Computational Foundry and work with partners and stakeholders globally.

This 5-year programme, funded by the EPSRC, is about re-orientating interactive AI systems, away from systems that might lead to people feeling powerless, redundant, and undervalued, turning towards approaches that let people experience joy, creativity, connection, and agency as they use AI innovations to amplify their innate abilities, qualities and values.

We will work intensively with people who are not usually involved in AI discovery and innovation - people with lower socio-economic opportunities in the UK and those in Global South communities such as the informal settlements in India, Kenya, Brazil, and South Africa. Their lived experiences will be brought into the design and development process. In doing so, we aim to discover novel ways for people - everywhere, whatever their contexts and opportunities - to engage with AI systems.

We call this new trajectory for AI research, EVE - everyone virtuoso everyday - to succinctly summarise the drive of the work. That is, we are interested in defining and evaluating a class of AI technology that enable expressive, individual, and masterful interactions, like a virtuoso musician who channels all their being - physical, mental, emotional, and even spiritual - through their instrument to help themselves and others make sense of the world.

One of the PDRAs will be an expert in HCI with a strong understanding of AI; and the other, a person passionate and innovative in AI/ML with a strong understanding of HCI. The roles will involve intense co-creation and collaboration and international travel. You will be based at the world-class Computational Foundry at Swansea University and help to further forge the vision and mission of the EPIC Centre that has pioneered people-first artificial intelligence for the past 5 years.

Swansea University
Prifysgol Abertawe

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To leap or not?

Most big life choices involve a gamble. But there are sound ways to decide whether to accept what we have or take a chance on what might be a better option, as **David Robson** finds

LIFE, it could be argued, is like a long game of blackjack. In one common version of this, each person is initially dealt two playing cards. The aim is for your hand to add to 21, or as close to this as you can get without busting. Players can either "stick" with their existing hand or "twist" – asking to be dealt another card to add to their total. The risk, of course, is that you exceed 21 and are eliminated.

This may sound far removed from everyday choices, but many of our most important life decisions boil down to such dilemmas. Should I stay put or take the leap and move house? Should I remain in my job or start my own business? Should I put up with an unsatisfying relationship or try my luck at love another time? In each case, we must weigh the security of what we have against a riskier, but potentially more rewarding, alternative.

The inherent uncertainty of these dilemmas leaves many of us dithering in analysis paralysis, so that we end up lingering in the status quo, never giving ourselves the chance to win big. Some people, in contrast, are too easily swayed by the lure of the new: they gamble too readily, until their impulsive behaviour has lost them everything. If either of these scenarios sounds familiar, help may be close by. Thanks to a growing understanding of our underlying cognitive biases and how to escape them, we now have evidence-based strategies to think about these quandaries more rationally – and so play the hand life has dealt us to our best advantage.

You may think that these dilemmas are unique to humans, but stick-or-twist decisions are rife in nature. A foraging animal, for example, must recognise that its current territory has limited resources and a more bountiful oasis may be lurking just around the corner. "There comes a point where individuals have to face this decision: do you just keep exploiting an area or do you do something riskier and move on to explore a new area?" says Samantha Patrick at the University of Liverpool, UK.

Cautious by nature

The relative merits of each option for any one creature will depend on the behaviour of the other members of their group. "If all individuals do exactly the same thing, that would then lead to a cost for everyone," says Patrick. This may help to explain why animals vary in terms of their boldness. Across many species, some individuals feel less threatened by the unfamiliar than others. The bolder ones will be more inclined to explore, while the more cautious ones will stay behind and make the most of what they already have.

Collaborating with researchers at La Rochelle University in France, Patrick explored this idea in a population of snowy albatrosses that had landed to breed in Australia on Possession Island in the Torres Strait off the northern coast of Queensland. Each bird can choose to feed from a restricted area of the ocean or take flight on a wind that carries them hundreds or even thousands of kilometres away from their current patch. Their dependence on the wind for navigation means they are unlikely to be able to return to their original feeding ground, says Patrick – meaning exploration is a risky strategy.

Her team assessed each albatross's boldness according to its reactions to approaching humans. Birds that showed great signs of distress as a person moved closer to their nest, such as making a racket or standing up, were rated as being shyer than those that demonstrated more muted reactions. Previous studies have found that this measure correlates with other measures of boldness, such as the birds' propensity to explore unfamiliar objects. Patrick's team discovered that it also predicted their tendency to explore other terrains, to take to the sky in search of riches elsewhere.

Humans have a wider range of situations to exploit or explore, but the binary nature of the decisions remains. "Exploitation-exploration dilemmas span the gamut in terms of biological complexity," says Daniel Yudkin, a visiting scholar at the University of Pennsylvania. An obvious example is immigration: throughout history, individuals and groups have had to decide whether to stay where they are or find fortune elsewhere. But it is equally relevant for many other dilemmas, from our romantic yearnings to our professional ambitions. ›

JON KRAUSE

PETER DAZELEY/GETTY IMAGES

"We're constantly making decisions about whether to stick with what we know or to go off in search of better horizons and take certain risks that could potentially lead to bad things happening, but which might also offer opportunities," says Yudkin.

Some people are born risk-takers. Like the bolder albatrosses, they feel less fear in uncertainty. At the extreme, these people may be willing to risk their lives for the thrill of the new. Most of us, however, have the opposite problem. We are far too conservative, even when it would be rational to take a gamble, due to a range of cognitive biases.

Consider the loss aversion bias. People tend to place far more weight on the resources they risk losing than the rewards they might obtain from taking a chance. Psychologists investigate this phenomenon using financial bets. Volunteers might be asked to imagine that they have been given $100, with the opportunity of investing it in a new company. There is a 50 per cent chance that this will earn them $150 on top of their original investment. If the company fails, however, they will lose all the cash.

For many people, the fear of losing the initial $100 looms larger than the possibility of gaining the even greater reward of $150, so they decide not to take the risk. This may seem to make sense in the short term, but if you are consistently averse to loss across many such bets, you will miss out on the chance to make a tidy profit. "The effects can add up over time," says Kellen Mrkva at Baylor University in Texas. His recent research shows that loss aversion is remarkably consistent across people of different incomes and educational backgrounds, and it seems to increase with age.

Another problematic bias is called the sunk cost effect. This is the tendency to continue with a failing project we have invested our resources into rather than pulling out and saving further expenditure in the long term. If you have ever continued to watch a film you weren't enjoying simply because you didn't want to "waste" the time already spent watching it, you have experienced one small example of the sunk cost effect. But it can equally apply to our careers and love lives.

A third subconscious motivator in these decisions is the status quo bias – a general tendency to favour our current situation over a change. We might always choose the same brand of car, for example, simply because it is familiar and we dislike the uncertainty of trying something new.

In isolation, these biases may seem fairly trivial. Over a lifetime, however, they can prevent us from taking a whole range of leaps into the unknown, even when there would be very good reasons for doing so. What's more, this psychological inertia has a lasting impact on our happiness, as Steven Levitt at the University of Chicago discovered in a rather ingenious experiment.

Levitt first set up a website in which people could describe a major quandary, such as whether to move house, quit their job, propose marriage, break up with their partner, start a business or adopt a child. The participants could then toss a virtual coin to guide their decision-making: if it landed on heads, they were advised to make the big life change; if tails, they were advised to remain in their current situation. Email questionnaires then tracked their progress for six months.

"There is no need to sweat the small stuff, since these decisions do little to affect overall life satisfaction"

It may seem remarkable that anyone would allow their thinking to be guided this way. Within a year, however, that virtual coin had been tossed more than 22,000 times – and the results were extremely revealing. On average, people who got "heads" were around 25 per cent more likely to disrupt the status quo and opt for the life-changing decision. What's more, whatever the website advised, the people who did this were much happier for it, compared with the people who stuck with their lot. Levitt also tracked people making lower-stakes decisions – such as whether to go on a diet, change their hair colour or get a tattoo – and this result didn't hold. This suggests that there is no need to sweat the small stuff, since these decisions do little to affect overall life satisfaction.

Levitt's results indicate that many of us could benefit from reappraising our circumstances and taking the occasional leap into the unknown. If we return to the blackjack analogy, we need to learn how to "twist" a little more often. But how to do that?

Perhaps we can learn a trick from "maximisers", individuals with a strong compulsion to find the optimal outcome for every situation. In psychological questionnaires, they are likely to agree with statements such as "I never settle for second best" and "Whenever I am faced with a choice, I try to imagine what all the other possibilities are, even ones that are not present at the moment". Recent research by Raffaella Misuraca at the University of Palermo, Italy, and her colleagues shows that maximisers are generally less susceptible to cognitive biases, including the sunk cost effect, which suggests they would be more willing to "twist" if their current options aren't working. And this approach to life certainly has some advantages. For example, among a sample of students looking for work, maximisers ended up getting a 20 per cent higher salary compared with "satisficers", people who tend to plump for the first acceptable option.

Nevertheless, there is a problem with this strategy. "Maximising makes the decision-making process extremely complex, difficult, stressful and emotionally draining," says Misuraca. There are simply too many options to weigh up the pros and cons of every choice. This can create psychological inertia: natural maximisers can feel so overwhelmed with the options, they simply don't make any choice. And if they do decide, the problems

“Many of us could benefit from reappraising our circumstances and taking the occasional leap into the unknown”

STURTI/GETTY IMAGES

Cognitive biases make us cautious when it comes to big dilemmas, such as getting divorced or moving house

WAVEBREAK MEDIA PREMIUM/ALAMY

A new hairstyle, or not? Such decisions matter far less

continue. “[Maximisers are] haunted by the doubt that a superior option might be among those they did not evaluate,” says Misuraca. Perhaps as a consequence, they tend to suffer badly from feelings of regret and “fear of missing out”, which takes a toll on their overall life satisfaction.

The challenge when faced with stick-or-twist dilemmas, then, is finding some kind of sweet spot between all these different tendencies. Most people should be a little readier to gamble when the odds are in their favour, but not so risk-prone that they throw all caution to the wind. We must be open to new options without constantly devaluing what we already have. And we need to be able to take some risks without always living in wistful regret of the path not taken.

Fortunately, burgeoning research in a field of psychology called “wise reasoning” points to a technique that appears to meet all these criteria. The strategy is known as psychological distancing, which is akin to taking a fly-on-the-wall view of things. There are many ways to apply it. You might imagine you are advising a close friend in a similar dilemma, for example, or you could try to predict how you would view the decision and its consequences at some time in the mid-to-distant future. If you happen to be multilingual, you can even achieve distance by thinking about a decision in a less familiar language. In each case, the aim is to look at our predicament from a wider perspective. “We’re inherently locked in a single point of view,” says Yudkin. “These sorts of exercises can kick us out of those cognitive ruts.”

Previous research has shown that psychological distancing techniques contribute to greater intellectual humility, which encourages people to consider more sources of information before coming to a judgement. And there is now good reason to believe it can gently nudge us out of our inertia in stick-or-twist dilemmas. For instance, studies show that psychological distancing improves people’s appraisals of potential losses and gains in a risky decision. According to recent research by Yudkin, it also increases our inclination to try pastures new. In his work, participants played a kind of treasure hunt in which they sought points hidden in a virtual landscape – with real financial rewards for their finds. To create psychological distance, some were asked to imagine playing the game on behalf of another person. Like the pluckier albatrosses in Patrick’s study, they were considerably more likely to venture into new territories, rather than stick to those they already knew.

Mrkva agrees that psychological distancing could help us to be a little braver in our decision-making. He points out that our minds often become anchored on past failures, which discourages us from taking similar risks again. Strategies to increase psychological distance could help us to put those disappointments in perspective, he says. “We need to look at the bigger picture, not just a single situation.”

This approach can also help us deal with the consequences of our big decisions. Research shows that, when using psychological distancing techniques, people are better able to regulate their emotions – which we must do to process the choices we have made. In addition, discussing life’s disappointments from such a distanced perspective helps us extract meaning from our experiences. That should prevent you becoming immersed in the feelings of regret that can follow stick-or-twist decisions.

As any gambler knows, Lady Luck won’t work in your favour all the time, no matter how smart your decision making has been. So you should try to celebrate your successes and learn from your mistakes. Nevertheless, by applying this psychological research, you can make the most of your hand – and take greater pleasure in the thrill of the game. ▮

David Robson is the author of *The Expectation Effect: How your mindset can transform your life*

Megaprojects that could save the world

WHEN it comes to fighting climate change, many strategies require relatively small actions from large numbers of people. It is about millions of us installing heat pumps, switching to electric vehicles, eschewing meat in our diets and so on. But given the sheer scale of the challenge, there are those who insist we need to think bigger and bolder too.

They are talking about audacious infrastructure projects that would cost billions and carry high risks, but could, if they work out, have a truly transformative impact on our stuttering efforts to get carbon emissions down to zero – and even mitigate the worst effects of current warming. They include plans to build a huge solar power station in space, regreen vast swathes of desert and prop up melting glaciers to hold back city-threatening sea level rise.

Here, we examine five of the most promising green megaprojects, weighing up their prospects and exploring what would need to happen next to make good on them. Realistically, what kind of impact could they have? And can we really pull them off?

01 Launch a solar power station into space

CLOUDS may be a source of inspiration for poets and romantics, but for solar power engineers, they are nothing but a nuisance. No matter how efficient the solar panel, when the sky clouds over, power output drops to nearly nothing. Move that solar panel into space, however, and this problem disappears. In orbit, a satellite can bask in the perpetual glow of sunlight and generate electricity at maximum capacity nearly all the time.

Engineers have been talking up the idea of a solar power station in space for decades, and when you look at how much energy it could produce, you can see why. A 10-kilometre-wide solar panel in geostationary orbit could produce 570 terawatt-years of energy, according to Ian Cash at International Electric Company. That would be enough to supply 10 billion people at six times the current US levels of energy consumption per capita. (For comparison, the UK's total electricity demand in 2022 was 320 terawatt-hours.)

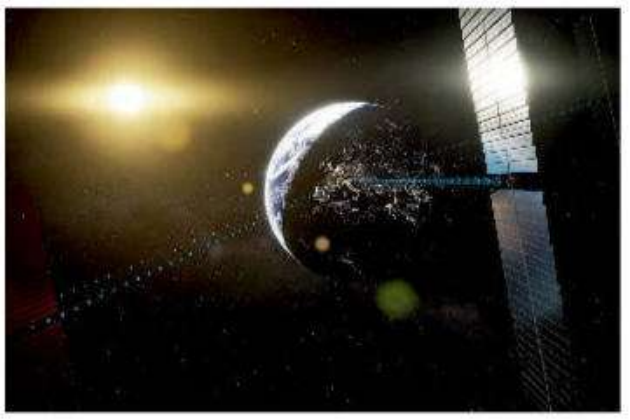
So, why haven't we done it? For a long time, the answer was cost. A spacecraft with solar panels extending for kilometres would be heavy, and launching all the required equipment into space would be horrendously expensive. But with the arrival of reusable rockets built by companies such as SpaceX, that price has tumbled. Estimates suggest that it could cost just $5000 per kilogram to send materials into geostationary orbit, where space solar power stations would need to sit, with SpaceX's upcoming Starship launch system. That is about half of what it costs with our most economical rocket technology today. "The advent of reusable launch vehicles completely changed the economics," says Martin Soltau, co-CEO of Space Solar, a UK company dedicated to the commercial delivery of space-based solar power.

Assuming that we can build a huge solar power station in space, we would then have to get the power back down to us. Fortunately, we know how to do this: microwaves beamed to a ground-based receiver called a rectenna. Researchers at the California Institute of Technology in Pasadena demonstrated this was feasible for the first time in February, as part of their Space Solar Power Project.

That was an important milestone. But if we had a truly huge solar plant in space (or lots of quite big ones), the rectennae would no doubt prove contentious. There would have to be roughly the same number of them as solar power satellites, and each would need a collecting area of around 20 square kilometres for each gigawatt that it was designed to receive. At that size, the best solution would be placing them offshore. Imagine a giant floating net of antennae, sitting above the highest waves. "In terms of offshore engineering, they're going to be much more straightforward than making offshore wind turbines reliably work for 25 years," says Soltau.

Perhaps the biggest uncertainty is whether the carbon emitted while making the solar panels and getting them into space would outweigh the benefits of space-based solar power. A study by Andrew Wilson at Metasat UK, a space sustainability start-up, looked at the effects of manufacturing and launching the infrastructure for 25 solar power satellites, each capable of generating 2 gigawatts of power on the ground (collectively, about as much as 620 wind turbines). He found that ›

AUKID/ADBOE STOCK



ESA/A. TREUER

Space-based solar power stations could be vast

this would produce about 80 per cent as much carbon as the UK does in a year. However, that would be paid back in carbon savings within six years and the system could operate for as long as 60 years.

Whatever the impact, interest in space-based solar power is growing. As well as the Caltech project, Japan and China have plans to build and test prototype solar power satellites in the next few years. At the European Space Agency, the Solaris programme is also investigating the concept's feasibility. If the UK puts its shoulder behind this, it might realistically aim to get about 30 per cent of its electricity from space by the early 2040s, says Soltau. **Stuart Clark**

02 Build a set of energy islands

IF DENMARK has its way, the cold and choppy waters of the North Sea will soon be home to a new island known as VindØ. Not a seabird and sand kind of island, but one of concrete, steel – and clean energy galore. The plans for VindØ are part of a broader scheme to solve the energy crisis by building artificial "energy islands" to support vast wind farms.

Europe already has a lot of offshore wind turbines. But energy industry insiders reckon we need vastly more if we are to successfully transition to net zero. "In the next 25 years, many countries are looking at building 10 to 15 times as much as we built in the past 35 years," says Samuel Magid at Copenhagen Infrastructure Partners, a green investment fund. "That's a huge challenge, and in order to succeed, we have to do things differently."

Wind power has two main drawbacks. One is that the power generation is intermittent, meaning it can be hard to match supply to demand. Another is that the power must be transported via cables to where it is needed on land – and the infrastructure required is wildly expensive, especially if each farm is connected through a dedicated cable, as at present.

Energy islands could solve both problems. They would act as hubs in a continental supergrid, with connections from the islands splitting off to several different countries. This would make it easier to balance supply and demand and mean fewer cables are needed overall. "Building anything offshore is expensive," says David Flood at Statkraft, Europe's largest generator of green energy. So the idea is to just build a select few islands that have a lot of connections to various nations. "It's like a mega junction box," says Flood.

Denmark's VindØ is one of at least four such islands intended for the North Sea. The Netherlands, Germany and Belgium all have plans to build similar structures. Each would be built of sand and concrete and would support a huge wind farm nearby. Put all the plans together and they would produce 56 gigawatts of power, roughly equivalent to that provided by 30 nuclear power plants.

The other big attraction of energy islands is that they could be used to produce clean fuel. Certain industries, such as air travel and steel and cement production, are hard to electrify, but could be powered by clean-burning hydrogen. Energy islands could act as hubs for its production, using the green electricity to power machines called electrolysers, which split water apart to make hydrogen. This could then be shipped or piped back to land.

For Magid, this is the real, long-term attraction of energy islands. "It costs five times as much to transport electrons through a cable as it does to transport the green hydrogen through a pipeline," he says. Perhaps the hydrogen could be converted into ammonia – much touted as a future shipping fuel – and the energy islands could also act as maritime refuelling stations.

Green fuel production will probably be a feature of a second generation of energy islands, says Flood. "You could imagine that you don't have cables at all, you are just producing huge volumes of green hydrogen," he says.

In that case, other locations could come into play. The sea off the west coast of Ireland, for example, has huge potential for wind generation, but it is largely untapped because the demand for electricity nearby is relatively low. It would, however, be a fantastic place to make green hydrogen. **Joshua Howgego**

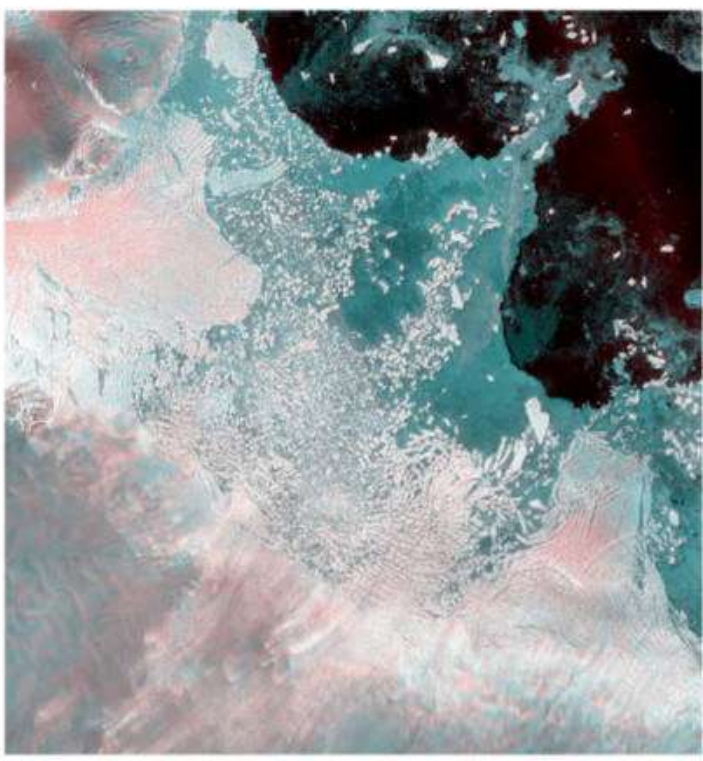
03 Stabilise the doomsday glacier

THE Thwaites glacier in Antarctica – often dubbed the "doomsday glacier" – is in deep trouble. Since 2000, it has lost more than a trillion tonnes of ice. The speed of its flow has also doubled in 30 years, meaning twice as much ice is being spewed into the ocean. Some think it is on a runaway path to collapse.

Even more alarmingly, this glacier buttresses much of the ice sheet covering West Antarctica. If Thwaites fails, the worry is that it will precipitate a widespread melting of the ice – a huge concern because this vast ice sheet contains enough water to raise global sea levels by up to 5 metres. "That will seriously threaten cities like New York, Shanghai, Calcutta and Hamburg," says Anders Levermann at the Potsdam Institute for Climate Impact Research in Germany.

John Moore at the University of Lapland in Finland has been exploring ways to shore up the Thwaites glacier for years now. He and his colleagues made several proposals in a 2018 commentary published in *Nature*. One idea was to bore through the glacier to extract the thin layer of water at the bottom that lubricates it and speeds up its flow. However, when Moore calculated the energy needed to bore multiple holes through the ice using a hot-water drilling technique – and keep them open in sub-zero temperatures – he baulked and largely abandoned the idea. "The amount of fuel you need is just insane," he says.

It might be better to protect Thwaites in a different way. One key threat is that increasingly



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warm seawater is seeping under the glacier's protruding ice shelf, melting it from beneath. Moore and his colleagues think that there might be a way to mitigate this by deploying a buoyant, 80-kilometre-long undersea curtain tethered to the seabed close to the glacier. The aim is to reduce the flow of warmer water reaching the ice. Early tests of a small prototype curtain by researchers at the University of Cambridge have just begun. "We've got to figure out a way to at least keep the ice where it is whilst we get greenhouse gas levels down," says Shaun Fitzgerald, who is co-leading this trial.

Needless to say, carrying out a massive engineering project in possibly the most inhospitable place on Earth won't be cheap. Moore estimates that the sea curtain could cost a whopping $50 billion to $100 billion. However, when you compare that with the tens of billions of dollars that individual cities like New York are spending on flood defences, he argues it is good value for money since it offers global protection.

Twila Moon at the National Snow and Ice Data Center in Boulder, Colorado, says that these geoengineering ideas give the "sense of assisting with the climate crisis, while failing to actually do that". But Moore doesn't see it that way. "No one is saying this is a substitute [for tackling emissions]," he says. "It's an extra tool. The best we can hope for is to avoid this collapse process, so the ice sheets gracefully retreat without very rapid sea level rise."

Ultimately, Moore thinks the stakes are high enough that these ambitious ideas are worth entertaining. "I don't think civilisation could manage without the West Antarctic ice sheet," he says. "It's an existential threat." **Alison George**

The Thwaites glacier is spewing ice into the ocean ever faster

About 10,000 years ago, the Sinai peninsula was green – but no longer

SHUTTERSTOCK/ANDREI BORTNIKAU

04 Regreen the Sinai peninsula

ONCE upon a time, the Sinai peninsula was a subtropical paradise. This area, in modern day Egypt, boasted rivers weaving through forests and grasses sparkling with dew. Then, around 10,000 years ago, the hills turned brown, rivers dried up and dusty sands drove away the remnants of life. Changes in Earth's orbit may have been partly to blame, but human intervention – felling trees and grazing animals – is probably what tipped the balance.

What if we could return the Sinai to its former Eden? In principle, the reintroduced vegetation would not only suck a huge chunk of carbon from the atmosphere, but also reinvigorate local water cycles, ushering in desperately needed rainfall and allowing flora and fauna to thrive.

The Sinai has the benefit of being well-studied for regreening by a Dutch firm called The Weather Makers. At the heart of the company's plan is Lake Bardawil, a shallow, saline lagoon on Egypt's Mediterranean coast. This was once 40 metres deep; today, you could find the bottom with a long stick and it is largely stagnant with little seawater exchange. Researchers at the firm would like to deepen the inlets to the sea and dig out the sediment that has built up in the lake itself over millennia.

According to The Weather Makers, this would improve the water quality and restore fish stocks. Both would be a welcome boost to the fishing industry in North Sinai, a region affected by poverty, terrorism and the war in neighbouring Gaza. Together with the planting of salt-tolerant species, the excavation would also help enlarge the surrounding wetlands, creating a better habitat for migratory birds. The sediment itself, being full of organic matter, could be worked into the land, improving its fertility.

There is only one thing missing: fresh water. Those at The Weather Makers have several ideas of how to capture it. One is to use fog collectors, taut nets erected at high altitude, on which atmospheric water vapour can condense and trickle down into reservoirs. Another idea is to store the excavated wet sediment in huge, lowland polytunnels, where its water content can evaporate before condensing on the structures and dribbling down to irrigate plants. Once the plants become sufficiently mature, the polytunnels can be moved elsewhere. Eventually, once a critical mass of land is regreened, the region's biosphere will naturally tip back to its former state and a self-sustaining water cycle will continue all the hard work – or so the idea goes.

Francesco Pausata, a climatologist at the University of Quebec in Montreal, cautiously welcomes the proposal, but thinks that the knock-on effects for the climate elsewhere need to be studied. "This sort of geoengineering can be good for the local population," he says. "But it's worth investigating in more detail to avoid unintended consequences."

At present, the Sinai plan is just an idea. The team at The Weather Makers is still in talks with the Egyptian government. But ›

Human activity has desertified vast tracts of land. Can we revive them?

EDWARD BURTYNSKY

many large-scale greening projects are well under way – for example, the African Union's Great Green Wall initiative, a 15-kilometre-thick strip of planted trees that is intended to stretch from Djibouti to Senegal. Another modern example is the Loess plateau in China, an area roughly the size of France that was reforested in 20 years, starting in the late 1990s.

The merit of these particular projects is debatable. The Loess plateau was transformed so quickly because it relied on unsustainable monocultures. "We need to realise that regreening projects are easy to market, but they are a distraction in most cases from [what ought to be] the real priorities and solutions of protecting the habitats we will otherwise lose," says Alice Hughes, a conservation biologist at the University of Hong Kong.

On the other hand, a 2020 study suggested that, in a little over 30 years, human activity and climate change has helped desertify 6 per cent of the world's drylands – that's some 270 million hectares. Plausibly, all of this desert could be regreened in a nuanced, sustainable manner that is sympathetic to the former habitats. **Jon Cartwright**

05 Suck 80 megatonnes of CO_2 from the air each year

OVER the next few decades, it won't be enough to merely avoid putting more greenhouse gases into the air. We also need to actively remove carbon dioxide to avoid the worst effects of global warming. There are plenty of ways to do that, including planting trees or restoring seagrass beds. But if you want to mop up CO_2 in an easy-to-quantify way with few uncertainties, then direct air capture is a solid – if expensive – option.

The idea is to absorb CO_2 from the air and then release a stream of the concentrated gas that can either be buried in the ground or sold as a useful product, such as synthetic jet fuel. In that sense, you can think of it as recycling CO_2.

According to the International Energy Agency (IEA), we will need to suck 80 megatonnes of CO_2 out of the atmosphere each year by 2030 in order to hit net-zero emissions by 2050. That amount of the gas is equivalent to what is produced by 185 million barrels of oil; it weighs nearly 15 times as much as the Great Pyramid of Giza.

This is a huge step up from where we are now. Today, there are 18 direct air capture pilot plants in operation globally, collectively sucking up just 0.01 Mt of CO_2 per year. The biggest of these is run by Swiss company Climeworks in Iceland: its Orca facility can soak up 4000 tonnes per year. A much larger effort is under way in Texas. The company 1PointFive broke ground in April 2023 for an industrial plant called Stratos, which aims to extract 500,000 tonnes of CO_2 from the air per year starting in 2025.

A handful of megatonne-scale plants are on the drawing board, but the pace needs to be dramatically accelerated. To reach our goal of 80 Mt per year by 2030, we would need to build about 10 such plants a year, starting now. That is epic, but viable. "It's technologically feasible," says Katie Lebling, an environmental analyst at the World Resources Institute in Washington DC.

How do we get there? Firstly, by improving the technology. For now, most direct air capture uses one of two main strategies.

"We need to build about 10 direct air capture plants a year, starting now"

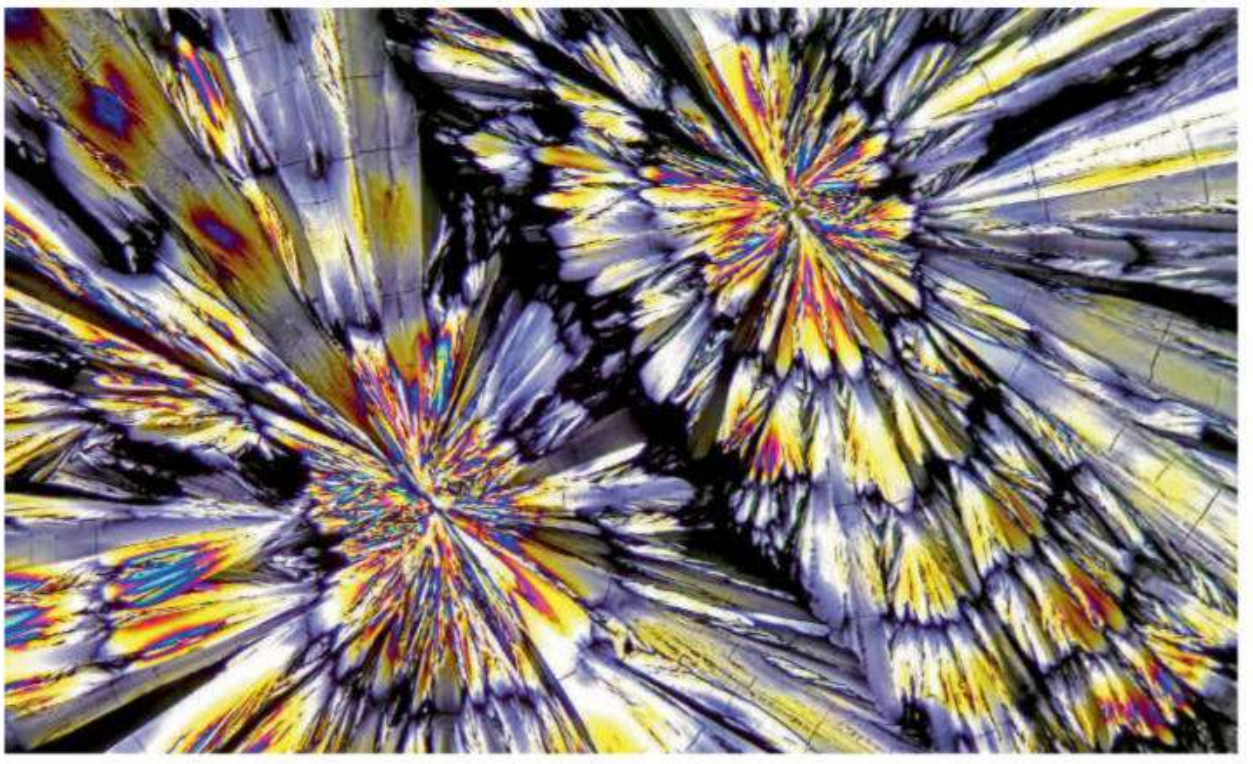
One soaks up CO_2 into a solid sorbent material and uses low pressure to pull the concentrated CO_2 out. That requires a lot of energy, says the IEA. (This is what the Orca facility does, using geothermal energy.) The other strategy, as followed by Stratos, for example, soaks up CO_2 into a liquid and then pulls it into limestone pellets that are heated at very high temperatures to release the CO_2. This process uses more water and typically burns fossil fuels to get the necessary heat.

Water and energy are big issues. In 2022, the IEA estimated that building and operating enough direct air capture plants to hit the 2050 target could require 50 gigatonnes of water per year – about 1 per cent of current global water use – and 6 exajoules (or 6 billion billion joules) of energy per year, which is also 1 per cent of current global use. Powering that with solar panels would require 23,000 square kilometres of land, which is perhaps another argument for putting the panels off-world (see "Launch a solar power station into space", page 37).

All this means that cost is a problem too, so we will need the right mix of policy incentives to get direct air capture going at scale. The good news, though, is that the plants can be built pretty much anywhere and relatively quickly. By 2050, with an investment boost, we could have dozens of 1-Mt-scale plants whirring away around the world. **Nicola Jones** ▮

KETAMINE ON YOUR COFFEE BREAK?

Psychedelic party drug ketamine is being repurposed as a therapy. But does its rising popularity pose worrying health risks? **Ruby Deevoy** investigates



M. I. WALKER/SCIENCE PHOTO LIBRARY

Ketamine crystals seen through a microscope

LAST year, to much ado in the press, Prince Harry wrote candidly in his memoir *Spare* about taking ketamine to help him deal with his mother's death. He isn't the only one talking about the substance, which has previously been known mainly as a horse tranquilliser and a psychedelic rave drug. It is hard to keep track of the many celebrities speaking openly about taking ketamine in an effort to improve their mental health.

Across the US, hundreds of clinics have opened to provide intravenous infusions of the drug in a therapeutic setting, a trend that has now reached the UK too. Trailblazing firms, worried about their employees' mental health, are starting to offer this therapy as a benefit. One even floated the idea of installing a ketamine clinic at its corporate headquarters. Meanwhile, pharmaceutical companies are developing over-the-counter ketamine products such as lozenges and topical creams. The drug has become the most commonly available psychedelic therapy.

That might sound like good news given the mounting evidence that ketamine can treat depression, post-traumatic stress disorder and addiction. Yet its use in treating mental health conditions is still novel and many uncertainties remain. Illegal use is rising too, perhaps influenced by its popularity as a therapeutic.

All this means it is time to ask whether ketamine really can soothe mental health problems, how it works and whether there are any risks to its new popularity. Psychiatrist Rupert McShane at the University of Oxford says he works everyday with people for whom ketamine is undoubtedly beneficial. "But it's a very bad idea for people to try and treat themselves," he says.

Ketamine has always been a tricky chemical to categorise. First synthesised in 1962, early trials in humans noted that high doses of ketamine knocked people out, but lower doses induced psychedelic effects. Over the following decades, it was embraced by both medics and ravers. After being approved as an anaesthetic by the US Food and Drugs Administration (FDA) in 1970, ketamine was widely used on battlefields in the Vietnam war, and is still routinely used as an anaesthetic in operating theatres. At clubs and after parties, ›

meanwhile, lines of ketamine are snorted recreationally to produce a euphoric, dream-like state often coupled with hallucinations, out-of-body sensations and sometimes complete sensory detachment.

Researchers first noticed the potential mental health benefits of ketamine in the 1990s – as an unexpected side effect in a study that used the drug to mimic the effects of schizophrenia. This was followed by small clinical trials that found people's symptoms of depression were rapidly alleviated when they were given ketamine via an intravenous drip. Unlike other psychedelics, ketamine has long been licensed as a medical anaesthetic by the World Health Organization, alongside many national health agencies. This means it can often be legally used "off label", paving the way for the first ketamine clinics, which opened in the US in the early 2010s.

Today, hundreds of private ketamine clinics operate across the US, offering intravenous drips that typically cost hundreds or thousands of dollars each. As of 2022, Ketamine Wellness Centers, then the largest clinic chain in the US, announced it had delivered 100,000 treatments. There are also a handful of private clinics in the UK.

Advocates of ketamine therapy point to a growing mental health crisis. Around 970 million people are affected by mental health issues worldwide. One common treatment is cognitive behavioural therapy, which teaches coping skills. But it isn't a cure-all. Meanwhile, treatments for depression specifically, which include SSRI drugs such as fluoxetine (Prozac) and electroconvulsive therapy, can have unwanted side effects. What's more, their efficacy is increasingly being questioned. Around one-third of individuals with major depressive disorder don't respond to antidepressant medication and the majority of people with alcohol dependence end up relapsing within six months of abstaining.

Ketamine is just one among many psychedelic therapies on which hope has been pinned in recent years. Promising clinical trials with substances including MDMA, LSD and psilocybin (the active compound in magic mushrooms) have spurred talk of a psychedelic renaissance. And with many decades of research and medical use behind ketamine, there is a clearer understanding of its benefits and risks over those of other options. As a relatively fast-acting psychedelic – with a trip typically lasting 30 minutes to an hour – ketamine also fits easily into a clinical setting. Other psychedelic therapies, which can last for many hours, require people to be closely monitored to reduce the risk of a "bad trip".

VICTOR LLORENTE/THE NEW YORK TIMES/REDUX/EYEVINE

Ketamine being administered via an intravenous drip at a clinic in New York

"Ketamine clinics can be more akin to a spa than a hospital ward"

The boom in ketamine clinics may be laying the groundwork for other psychedelic therapies to be made legal. Last July, for instance, Australia became the first country to legalise MDMA and psilocybin for therapeutic use. Yet the addictive nature of ketamine and associated risks mean that many experts don't regard it as the best option for psychedelic therapy. "It can lead to bladder damage and cognitive impairment when abused," says McShane. All of which poses questions about whether ketamine therapy should be more widely adopted, and how this might be done.

Part of the problem is that we still don't have a clear picture of how ketamine therapy works. Broadly speaking, psychedelics are thought to increase neuroplasticity – our brain's ability to remodel itself – allowing people to reconfigure potentially harmful mental ruts. Ketamine, for instance, promotes the long-term growth of root-like structures in neurons called dendrites that convey electrical signals. This, quite literally, provides a new network of possibilities and presents new ways of thinking about old problems.

Opinions differ on whether having a trip is essential to spurring these brain changes. It might be that ketamine acts on a molecular level and the psychedelic experience is a transient side effect. Nevertheless, some experts say the trip is crucial if ketamine is to have a profound effect. "It's within this experience where people have these incredible spontaneous recoveries of childhood memories

New Scientist video
Watch video accompanying this feature and many other articles at youtube.com/newscientist

and pivotal trauma that could be interpreted in a therapeutic context," says Celia Morgan at the University of Exeter, UK. The experience is often emphasised at ketamine clinics, too, which can be more akin to a spa than a hospital ward – featuring calming decor, weighted blankets and the occasional gong bath.

Part of the confusion around whether the trip is needed lies in finding quantifiable ways to measure psychedelic experience. Currently, a muddle of "dissociation scores" based on post-trip questionnaires are used, which are often in disagreement, says Marco Fabuš at the University of Oxford. By using an electroencephalogram headset to observe the brainwaves of people given ketamine, Fabuš is developing a more precise benchmark for the intensity of the experience. Unusually, unpublished research has shown that taking ketamine increases gamma wave activity in the brain and decreases delta wave activity – respectively resembling the brain states of people who have taken psychedelics and those of people under anaesthetic. "Ketamine sits in this weird in-between," he says.

Whatever the mechanism, ketamine has shown some remarkable results in recent large-scale clinical trials, proving to be an effective treatment for depression, addiction and chronic PTSD. Bookending ketamine infusions with talking therapy can boost and extend the effectiveness of treatment further. In a recent trial of ketamine assisted therapy (KAT) for alcohol addiction, Morgan and her colleagues found that 40 per cent fewer people relapsed if given ketamine with psychotherapy compared with ketamine alone. "Patients feel like an active agent in their recovery," says Morgan. "It's a really exciting paradigm shift that brings psychology and psychiatry closer together."

The corporate world is taking note of these trends, too. Since 2022, the US-based natural soap company Dr. Bronner's has offered its employees medical coverage for KAT via the heath insurance provider Enthea. Seven per cent of people with this coverage underwent KAT in 2022 as a treatment for depression, PTSD and anxiety. Enthea, meanwhile, says that 12 US firms are offering KAT to 2000 employees in total. One company even floated the idea of bringing ketamine clinics in-house, says Enthea's CEO, Sherry Rais.

At-home psychedelia

Corporate sanctioning of ketamine has justified its use to some employees, who were previously wary of the drug's reputation. "We're getting over quite a huge stigma with ketamine therapy," says Rais. "People have said that they wouldn't have tried [KAT] because they didn't trust it was a valid treatment," but their company validated it for them.

Amid the shift, pharmaceutical companies spied an opportunity to develop new ways to administer ketamine. Nasal sprays and ketamine lozenges to treat depression are now available, as is a topical cream to treat PTSD. These formulations are designed to be self-administered at home, used daily or even more frequently. In the US, unsupervised methods like this are being offered via telemedicine – a service that provides healthcare online or over the phone without the need for an in-person doctor appointment.

The easy availability of at-home ketamine treatments concerns McShane. "Self-medicating or recreational patients use higher doses than they would have administered in a clinical setting, and they use it more frequently," he says. Bolstering McShane's concerns, a survey of 2000 adults from US addiction treatment centre All Points North found that more than half of those who tried at-home ketamine therapy reported accidentally or purposefully using more than the recommended dose. The side effects of ketamine are only minimal when it is used occasionally, says Henry Fisher at Clerkenwell Health, a private company that specialises in psychedelic clinical trials. "Ketamine isn't meant to be something that's administered every day, every week or even every month for years," he says. "That's where we're headed. There's a commercial model that incentivises companies to move in that direction."

Illicit ketamine use has spiked in recent years, too, although its relationship to the expansion of therapeutic ketamine use remains unclear. In 2022 in the US, for instance, about 12 times as much ketamine was seized by enforcement agencies compared with 2017.

This is cause for concern given the well-established potential for ketamine abuse. "Compared to something like psilocybin, for example, it's more likely to be habit forming," says Fabuš. In October, the FDA issued a warning about the possible harms of accessing ketamine via telemedicine and emphasised that ketamine isn't FDA-approved for the treatment of any psychiatric condition.

The death of *Friends* actor Matthew Perry, who was found unresponsive in a hot tub at his home in October is a concerning example. Ketamine was listed as the primary cause of death on his autopsy report. Perry was receiving KAT for anxiety and depression but, given the time of death, it was unlikely the quantities found in his bloodstream came from a clinic, the coroner wrote.

Ketamine probably isn't the best option when it comes to psychedelic therapies, says Fisher, rather it is the most convenient. "There's been a lot of hype, but it might not be for everyone and the effects might not be long-lasting." Despite this, the infrastructure being built around KAT remains a useful precursor for rolling out other psychedelic-assisted therapies, he says. Ketamine therapy is unlikely to jeopardise the adoption of psychedelic therapies more broadly, says Morgan, and more to the point, it is already available. "Ketamine can be used right now, with no regulation changes required," she says. "This is really valuable and, given the current mental health crisis the world is faced with, very much needed." ▮

JONATHAN FISHER/MILLENNIUM IMAGES, UK

Ketamine can produce a euphoric, dream-like state often coupled with hallucinations

Consult your doctor before changing your treatment plan.

Ruby Deevoy is a cannabis and psychedelics journalist based in the UK

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
Do climbing plants twine in only one direction? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Edible robots, sliceable ketchup and financial smirks p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Stargazing at home

Spring ahead

As the equinox approaches, it is a great time to spot the Spring Triangle, wherever you are in the world, says **Abigail Beall**

Abigail Beall is a features editor at *New Scientist* and author of *The Art of Urban Astronomy*. Follow her @abbybeall

THE 20th of March marks the vernal, or spring, equinox in the northern hemisphere, and the autumn equinox in the southern hemisphere. On this day, most places in the world will get around 12 hours of daylight. The days are getting shorter in the southern hemisphere, while many of us in the northern hemisphere are looking forward to signs of spring.

But wherever you are, this is a great time to spot a pattern of stars known as the Spring Triangle. It is worth looking for no matter where you live, even in areas with light pollution, because the three stars that make it up are bright enough to compete with city lights.

Its name may suggest it is only visible to those of us entering spring, but the Spring Triangle (pictured, right, as viewed from Canada) can be seen as far south as Queenstown, New Zealand. The asterism – a pattern of stars that isn't an official constellation – is made up of three stars from three constellations: Arcturus in Boötes, Spica in Virgo and Denebola in Leo.

It is easiest to start with Arcturus. In the southern hemisphere, Arcturus will be the bright star near the horizon directly due north-east about 5 hours after sunset. It will then be visible throughout the night, moving north as the night goes on. Arcturus is the fourth brightest star in the sky, so it should stand out from the others around it.

In the northern hemisphere, you can use the Plough, or Big Dipper, which is part of the constellation Ursa Major. Look at the line of stars that forms its handle, then follow the arc of this curve away from the Plough and you will get to a bright star, Arcturus. It will be visible near the eastern horizon from as soon as the sun has set. I like to remember this technique by thinking of "arc to Arcturus".

ALAN DYER/STOCKTREK IMAGES/ALAMY

Once you have found Arcturus, the rest of the triangle can go from here. In the southern hemisphere, Spica in Virgo will be the bright star almost directly above Arcturus, while Denebola, in Leo, will make the third point in an almost equilateral triangle, off towards the north, or left, of them both. In the northern hemisphere, the triangle will appear in a different formation. Spica will be the last star to rise, so you might have to wait until 3 hours after sunset to see it low in the eastern sky. It will appear below and to the right of Arcturus. Above and to the right of Spica will be Denebola.

Wherever you are looking from, you can make sure you have the correct stars using any free stargazing app. Or you can check that Denebola is the right star by looking away from the triangle in the direction of Denebola – if you see what appears to be an upside-down question mark (in the southern hemisphere) or a backwards question mark (in the northern hemisphere), you have found the sickle of Leo, and you are in the right place. ▮

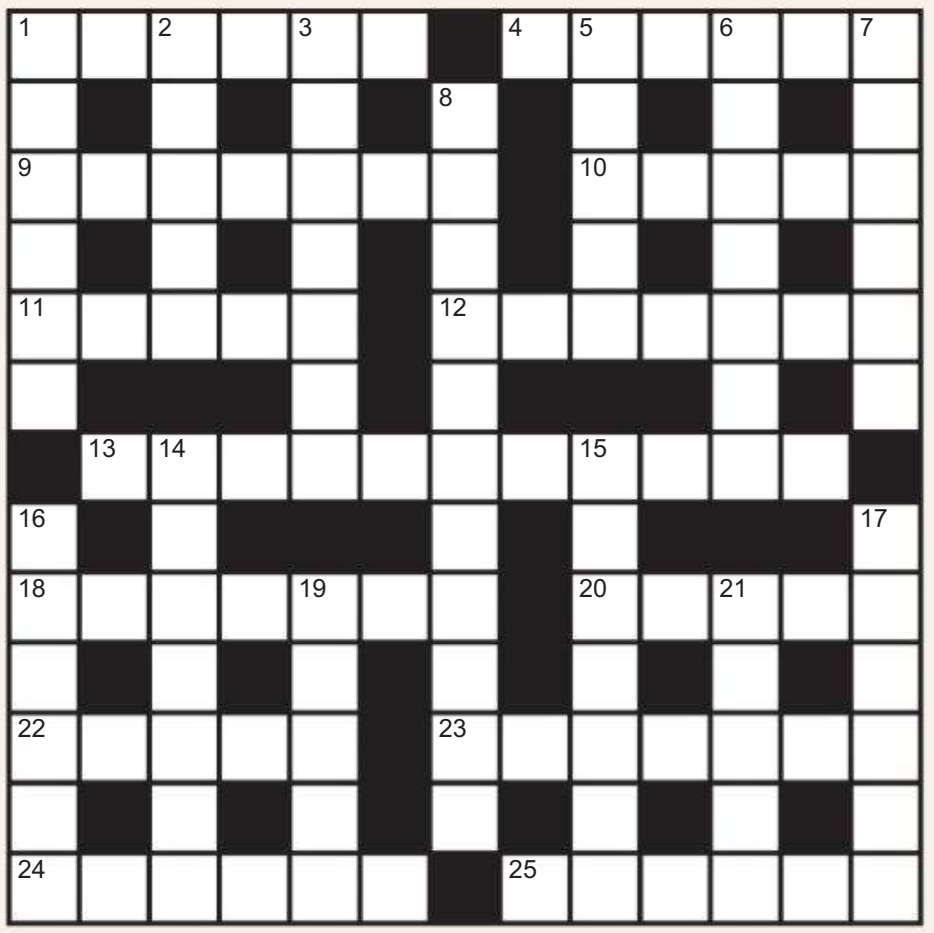
Stargazing at home appears every four weeks. Share your stargazing successes with us on Twitter and Instagram @newscientist, using the hashtag #NewScientistStargazing

These articles are posted each week at newscientist.com/maker

Next week

Mathematics of life

Cryptic crossword #131 *Set by Trurl*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Inhaled weird nitrogen mixture (4,2)
4 A great deal with US state organ (6)
9 Unable to mingle without drug (or "space clouds") (7)
10 Rugger chaps in lower chamber (5)
11 Needle user in a crappy way? (5)
12 As arcsine, complicated (7)
13 One tree beside puddle in Indian city (11)
18 Bauxite, say, with last of topaz, boron, uranium and sulphur, all turning very cold (3-4)
20 Predator's pastime (5)
22 It's meant to decrease body odour and to fix backside (5)
23 Something for burning anger (7)
24 At first run extremely fast, then ease off (6)
25 What unsettled winger might do, being briefly offside in centre (3,3)

DOWN

1 Like Bohr, getting something for breakfast (6)
2 Dropping a bass to shake up joint (5)
3 Sick, staff of life? I hear it's very common (3-4)
5 Folk dance without leader, something rootsy (5)
6 Professor's class remains chaotic (7)
7 Parisian one occupying ornate folly (6)
8 Director Gibson to make fast cut, putting trouble back in *Misery* (11)
14 Rail to British capital in a terrible state – like the M25! (7)
15 Fiddle, lie and heartlessly cheat – you won't be this (7)
16 Is nothing but a line on a map? (6)
17 Half of tall story supported by novelist (me) (6)
19 Oil company, one no longer seeing rising air pollutant (5)
21 If picked, it may produce air (5)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #243
set by Bethan Ackerley

1 Human immunodeficiency virus (HIV) is an example of what type of virus?

2 What name is given to areas of open water that are surrounded by sea ice?

3 The first known land plants emerged in which geological period?

4 Name the astronomer who wrote the 1985 science fiction novel *Contact*.

5 Where would you find Darwin's tubercle?

Answers on page 47

BrainTwister
set by Peter Hajek and Sam Hartburn
#11 Club shuffling

I play golf with three of my friends, and we split into two teams for each game, one team against the other. We change partners after each game until every possible pair of teams has played.

How many games will be played altogether?

If I win all my games, how many games can each other person win? What if I lose all my games?

If we add two more friends to the group and play in two teams of three instead, how does this change the answers to the questions above?

Solution next week

What a twist

All the climbing plants and weeds in my garden twine anticlockwise. Is there an evolutionary advantage to this? And do any twine clockwise?

Penelope Reid
Loggerheads, Staffordshire, UK
I am sure I will be among many of your older readers who recall the tragic ballad of doomed lovers, *Misalliance*, sung by Flanders and Swann.

In the song, a honeysuckle and a bindweed fall in love and intertwine. Sadly, the honeysuckle's parents disapprove because the superior honeysuckles twine to the right and the plebeian bindweeds to the left, leaving any prospective offshoots of the match to be directionless and fall flat on their faces. This and the general disapproval leads to the lovers pulling up their roots and shrivelling away.

Norman Doidge
Newton Abbot, Devon, UK
When looked at from below, bindweed twines anticlockwise while honeysuckle goes clockwise. I fear your correspondent's weeds are the former. And good luck controlling that. Is there some

"In the tragic ballad about a honeysuckle and a bindweed, sadly honeysuckle's parents object as they twine in different ways"

evolutionary advantage? Perhaps, but either way is definitely better than not twining at all. "It may go straight up and fall flat on its face", as per Flanders and Swann.

Mike Follows
Sutton Coldfield, West Midlands, UK
In the absence of a skeleton and muscles to articulate it, plants have evolved ingenious ways to move. Instead of growing thick trunks to reach sunlight, climbing plants like sweet peas and cucumbers expend less energy by sending up spindly tendrils. The ends of these tendrils wave around in the air, apparently searching for something to cling onto in a process called circumnutation.

When the end of the tendril encounters something, it twines itself around the support. Once anchored, the rest of the tendril coils up like a corkscrew and, in the process, shortens. This pulls up the rest of the plant.

In 1865, Charles Darwin noted that the upper and lower halves of the cucumber tendril were separated by an untwisted stretch, called a perversion, and that each half had the opposite chirality or handedness (twist direction). Coiling with the same handedness along the whole length of the tendril would have imparted a twisting force or torque, either on the cucumber or its support.

In 2012, a Harvard University investigation into cucumber (*Cucumis sativus*) and wild cucumber (*Echinocystis lobata*) discovered a stiff ribbon of specialised cells inside each tendril. The researchers suspected that cells on one side of the ribbon shortened, bending the tendril in that direction and making it coil.

They observed that the ventral cells (those on the inside of the spiral) produce more of the polymer lignin than the dorsal (outside) cells and speculated that, because lignin is hydrophobic, these cells expel more water and contract more than the dorsal ones. They built a model by bonding together two silicone rubber sheets while one of them was under tension. They then cut the rubber into strips along the strain axis and these mimicked the coiling of the tendrils, including the presence of the perversion.

However, instead of unravelling when stretched as their model did, real tendrils tend to twist even more tightly at first, before eventually straightening with the application of more tension than is expected. This ensures a tighter grip between the climbing plant and its support. It also results in a spring-like connection between the plant and its anchor that acts as a shock absorber in high wind. The team was able to modify the model to replicate this behaviour.

Given that Darwin identified four classes of climbing plant, the Harvard investigation may not be universally applicable to the behaviour of all tendrils.

Jan Henslow
Midhurst, West Sussex, UK
Yes, they do also twine clockwise. Charles Darwin wrote about this in *The Movements and Habits of Climbing Plants*, of which Ken Thompson's *Darwin's Most Wonderful Plants* gives an easy-to-read synopsis, brought up to date. It seems climbers swing around in either a clockwise or anticlockwise fashion until they hit something to wrap around, thus twining in a left or right-handed spiral. Whether they swing to the left or right seems to be just like people – mostly right-handed but some left (92 per cent right-handed in plants, apparently).

Elspeth Semple
Inveresk, East Lothian, UK
In my garden, I am blessed with right-handed honeysuckle, but tormented by the beautiful yet persistent left-handed bindweed. So there are climbing plants in the UK that twine clockwise and others that twine anticlockwise.

TRAVELLINGLIGHT/ALAMY

How would ancient Britons have measured the days in order to mark solstices at Stonehenge?

This week's new questions

Timing it right **If Stonehenge is a giant calendar, how did the ancient Britons measure the length of days precisely enough to put the Heel Stone in just the right place to mark the solstices?** ***Derek Peters****, Waddesdon, Buckinghamshire, UK*

Irritating question **Why do we tut when we are annoyed?** ***Alexandra Thompson****, London, UK*

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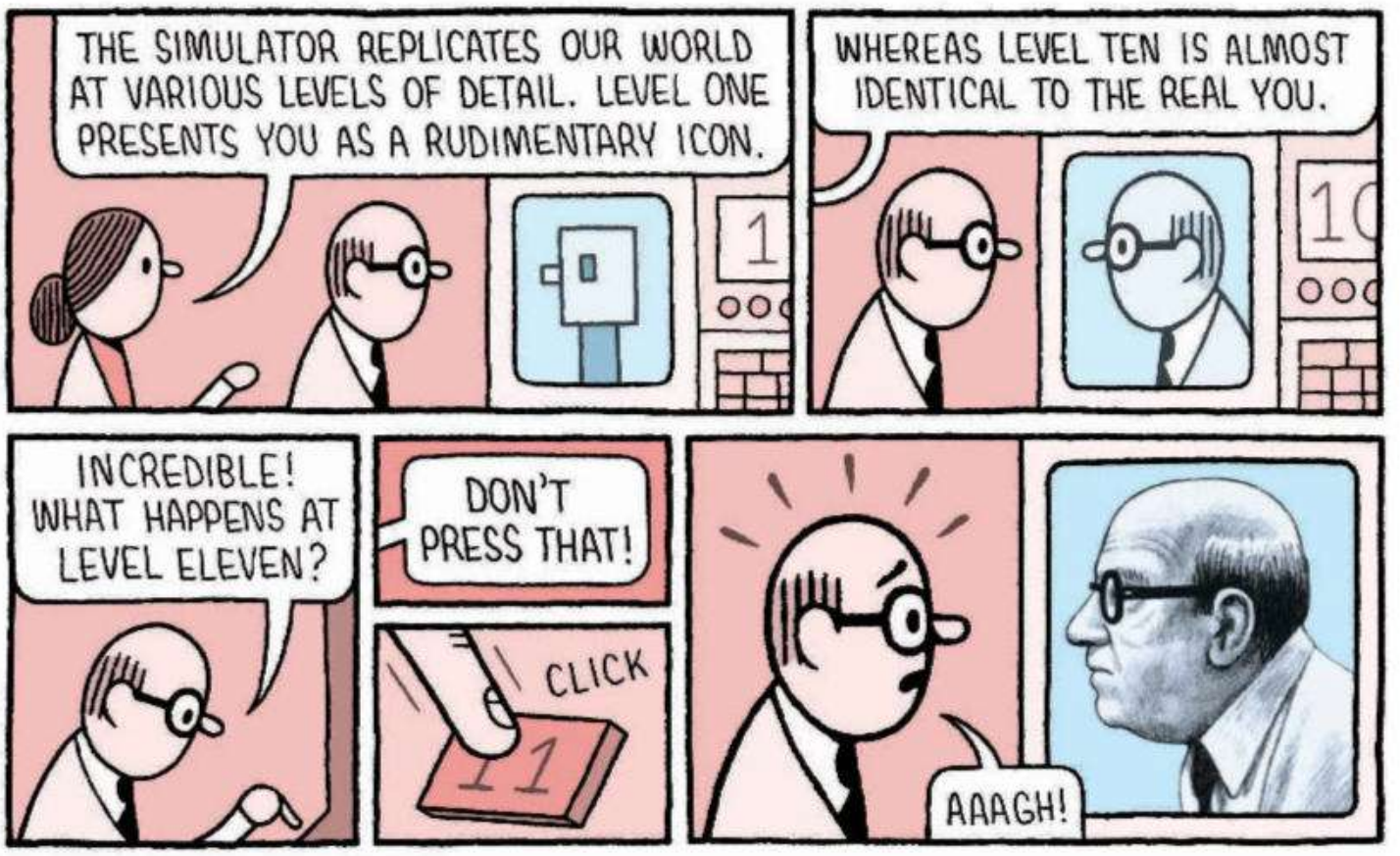
Tom Gauld
for New Scientist


THE SIMULATOR REPLICATES OUR WORLD AT VARIOUS LEVELS OF DETAIL. LEVEL ONE PRESENTS YOU AS A RUDIMENTARY ICON.
1
WHEREAS LEVEL TEN IS ALMOST IDENTICAL TO THE REAL YOU.
10
INCREDIBLE! WHAT HAPPENS AT LEVEL ELEVEN?
DON'T PRESS THAT!
CLICK
11
AAAGH!

Best thing since

What is the best way, and best knife to use, to minimise crumbs when slicing bread, particularly wholemeal?

Mark Wareing
Ashbourne, Derbyshire, UK
Wholemeal bread can be quite crumbly because the protein structure (formed from gluten) is weakened by the fibre and husk in the wholemeal flour.

This crumbling can be reduced by using wholemeal flour with a high gluten content (so-called strong wholemeal flour) or by including a small amount of very strong white flour or pure, "vital" wheat gluten.

The design of the knife needs to be able to penetrate the relatively hard crust without the bread being squashed during cutting, as this spoils the texture. The best knife for doing this is one that is serrated or that has small teeth, and the bread should be cut with a sawing action to avoid squashing it. The blade should be straight and the handle ideally angled upwards a little so that the user's knuckles don't hit the kitchen surface at the bottom of the cut.

"In the absence of any constraints on practicality, an industrial laser cutter seems hard to beat for slicing bread"

Freshly baked bread is less likely to be crumbly.

Anthea Fleming
Melbourne, Australia
I have the world's best possible bread knife, a family heirloom, which probably dates from before the second world war.

It has a thin, flexible steel blade about 20 centimetres long and 2.5 centimetres high, with a finely serrated edge. The turned wooden handle is about 10 centimetres long and was originally painted green, as were many kitchen knives of that era.

My bread-cutting technique is simply to cut across with a gentle sawing action from the top until close to the bottom, then I turn the loaf on its side to complete the cut.

The slice can be thick for toast or thin for sandwiches, just as you please. Not many crumbs result on the bread board – a traditional wooden type. My relatives complain that they can't buy a bread knife like mine these days.

Richard Miller
London, UK
In the absence of any constraints on affordability, practicality or edibility, an industrial laser cutter seems hard to beat.

The beam can be tightly focused (so that no more material is removed than necessary), no shear force is exerted on the loaf that might cause crumbs to be torn away from it and the laser provides the added benefit of cauterising as it goes, fusing potential crumbs to either side of the cut.

An excellent demonstration of this is available online at bitly.ws/3eAaM. ▮

Answers

Quick quiz #243 *Answers*

1 A retrovirus
2 Polynyas
3 The Ordovician
4 Carl Sagan
5 On the ear

Quick crossword #153 *Answers*

ACROSS 1 Remote, **4** Headache, **10** Culture, **11** Inspire, **12** Code, **13** Adrenaline, **15** Edward, **16** Asphalt, **20** Isotope, **21** Tsetse, **24** Woodpecker, **26** Loop, **28** Fan palm, **29** Trefoil, **30** Steaming, **31** Baryon

DOWN 1 Ricochet, **2** Meltdowns, **3** Thud, **5** Epilepsy, **6** Dysraphism, **7** Cli-fi, **8** Eleven, **9** Bendy, **14** Protoplasm, **17** Lithotomy, **18** Specimen, **19** Zeppelin, **22** Swifts, **23** Delta, **25** Ounce, **27** Zeta

#10 Chairs in pairs *Solution*

There are n seats in which to place Abbie. For each, there are n-1 places to seat Bryn. So there are n(n-1) ways to seat them both. Considering adjacent ways, there are n-1 ways to do this among n seats. For each, there are two arrangements (AB and BA), hence there are 2(n-1) ways they can be adjacent. So the probability of this is 2(n-1)/n(n-1) = 2/n. For n=4, this is 1/2. For n=20, this is 1/10. When seating people in pairs, we can think of them as one person taking up two chairs. We therefore want to seat two pairs, AA and BB, plus 18 singles, so imagine you arrange AA and BB among 20 positions, as in the second part of this BrainTwister, then swap their chairs for double chairs to seat their partners. The probability is therefore also 1/10.

Who eats whom?

Will robots eat us? Or will we eat robots? Both technophiles and -phobes have hungered to learn which will happen first. The answer has now arrived, in a report from a team at the University of Electro-Communications in Tokyo and at Osaka University, Japan.

Reader Bruce Gitelman alerted us to this summary passage: "We developed a pneumatically driven edible robot using gelatin and sugar. We examined its perceived appearance and the participants' impressions when it was eaten."

The researchers probed for the psychological reactions of their human subjects. "We evaluated two conditions: one in which the robot was moved and one in which it was stationary. Our results showed that participants perceived the moving robot differently from the stationary robot, leading to varied perceptions, when consuming it. Additionally, we observed a difference in perceived texture when the robot was bitten and chewed under the two conditions."

This is yet another example (Feedback previously mentioned a case involving ducks and monkeys) of the prescience of Stephen Sondheim when he wrote the musical *Sweeney Todd: The demon barber of Fleet Street*. Sondheim has Sweeney say: "The history of the world, my sweet, is who gets eaten and who gets to eat!"

Twisteddoodles *for New Scientist*

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Ketchup inside

Sliceable sauces of many kinds have yet to become popular. For the mo, technological hopes and resources are pouring onto ketchup. Ketchup eaters, as well as food technologists, can satisfy some of their hunger for knowledge by reading the study "Textural and rheological properties of sliceable ketchup", published in the journal *Gels*.

"There is a lack of knowledge on sliceable ketchup," explain the authors, who are based at three institutions in Iran: Islamic Azad University, Allameh Tabataba'i University and the Research Institute of Food Science and Technology.

For readers unversed in the field of sliceable sauces, they explain: "Ketchup for use in combination with sausages, as a final product, must have a high viscosity, and in terms of texture properties, it should be elastic and solid-state, and if cold, it can be cut and is sliceable like a sausage." If successful, this research could let ketchup be more than just an exterior sticky coating. The interior beckons.

The research goal is "to investigate the effect of gelling hydrocolloids on the physical, textural, and rheological properties of ketchup and to develop a new formulation for sliceable ketchup and its combined application as a filler in meat products such as sausages".

So, we have a rarity: cutting-edge ketchupry.

Ketchup on glass

Catching up on ketchup news that broke just as the covid-19 pandemic was seizing everyone's attention, Feedback finds that in 2020, at the Seventh European Seminar on Precision Optics Manufacturing in Teisnach, Germany, manufacturers were told about the benefits of putting ketchup on glass.

Max Schneckenburger and his colleagues at the Centre for Optical Technologies in Aalen, Germany, introduced their peers to what, for some, was a new concept: "High precision glass polishing with ketchup".

Their presentation explained the advantages of polishing with a "non-conventional", non-Newtonian fluid that "flows slowly under its own weight and acts like a solid body during short periods of stress as its viscosity increases".

Thus, ketchup, which in some circumstances behaves in non-Newtonian ways. They praise its behaviour: "Tomato ketchup shows a time-dependent change in viscosity: the longer the ketchup undergoes shear stress, the lower is its viscosity. Therefore, in this article, a new processing is put forward to polishing glass surfaces with ketchup containing micro-sized Ce_2O. Besides conventional ketchup, curry ketchup and an organic product were tested as well."

Schneckenburger's team used an industrial robot to guide the polishing head. This was, to the best of Feedback's knowledge, the first reported intentional instance of robots on ketchup on glass.

Financial smirks

You are correct if you suspect there are smirks inside the financial industry, deep behind the sombre, serious facades of buildings, business suits and coiffures. Many top finance analysts, in their daily work, investigate these smirks.

What is a financial smirk? The Options Industry Council, which advises investors, explains, somewhat, that "When mapping implied volatility levels, the curve these points create is typically identified as either a 'smile' or a 'smirk' depending on the shape created by the level for out-of-the-money puts and calls".

In Feedback's volatile understanding of that concept, this kind of smirk is a graphic, lopsided grin – something you see in plots if you have access to certain kinds of financial data.

But almost no one outside the industry sees these smirks.

That hiddenness resonates with an observation made half a century ago by economist John Kenneth Galbraith about the chosen demeanour of finance executives. "Nobody," said Galbraith, "nobody wants a funny banker." ▮

Marc Abrahams

DO YOU KNOW WHAT MAKES AIRPLANES FLY?

A. NEWTON'S FIRST LAW
B. NEWTON'S SECOND LAW
C. MURPHY'S LAW
D. BERNOULLI'S PRINCIPLE

TESTYOUR
SCIENCE
KNOWEDGE

TAKE
THE
QUIZ

QUIZIZZ

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